APPENDIX D

Site-Specific Modeling and Development of Screening Levels for the Protection of Groundwater

Appendix D

Site-Specific Modeling and Development of Screening Levels for the Protection of Groundwater

1. CALCULATIONS OF SITE-SPECIFIC SOIL SCREENING LEVELS FOR VOLATILE ORGANIC COMPOUND (VOC) CHEMICALS OF POTENTIAL CONCERN (COPCs) FOR PROTECTION OF GROUNDWATER

The site-specific soil screening levels at various depths for the VOC COPCs listed in Section 4.3 of the Feasibility Study (FS) were estimated following the procedures based on the Attenuation Factor (AF) Method developed by the California Regional Water Quality Control Board (RWQCB), Los Angeles Region in their guidance document “Interim Site Assessment & Cleanup Guidebook”. The calculations were implemented in Mathcad® (Parametric Technology Corporation, 2007)[1] worksheets. Mathcad® is a general-purpose mathematical analysis software that is commercially available.

When available, the maximum attenuation factors (AFmax) in the Los Angeles RWQCB guidance document were used. For other VOCs that do not have AFmax in the guidance document, the maximum attenuation factors were calculated from properties of the VOCs following the procedure in the Los Angeles RWQCB guidance document. The VOC properties used in the calculation of AFmax were obtained using the U.S. EPA document “Regional IX Preliminary Remediation Goals” (2004),[2] with the exception of isopropyltoluene. The references for the properties of isopropyltoluene were listed in the corresponding Mathcad® worksheet.

Modification factors for the distance above groundwater were applied to the maximum attenuation factors using equations 5 through 7 in the Los Angeles RWQCB guidance document. Modification factors for lithology were then applied to the attenuation factors using equation 12 in the Los Angeles RWQCB guidance document. The site-specific lithologic profile interpreted based on the logs of borings 125 and 126 were

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[1] Parametric Technology Corporation, 2007, Mathcad (version 14.0), Needham, Massachusetts, February.

[2] U.S. Environmental Protection Agency (EPA), 2004, Region IX Preliminary Remediation Goals, (PRGs) 2004.

used in the calculations. At each depth interval, the lithologic unit was classified as gravel, sand, silt, or clay layer. Finally, site-specific soil screening levels were calculated using the attenuation factors (modified for distance to groundwater and lithology) and maximum allowable concentrations in groundwater. The California Department of Public Health (DPH) maximum contaminant levels (MCLs) were used to calculate the site-specific soil screening levels. In cases where a compound did not have a State or Federal MCL, the DPH notification level was used, with the exception of isopropyltoluene. Because no DPH notification level is available for isopropyltoluene, the DPH notification level for isopropylbenzene was used as a surrogate. The calculations for the soil screening levels for the VOC COPCs are presented in Worksheets D-1 through D-14.

2. SITE-SPECIFIC MODELING OF PCBS IN SOIL AND CONCRETE FOR PROTECTION OF GROUNDWATER

Use of the AF Method in the Los Angeles RWQCB guidance document to evaluate polychlorinated biphenyls (PCBs) in soil and concrete for potential impacts to groundwater is not appropriate because PCBs have significantly higher soil sorption than VOCs for which the AF Method is applicable. The AF Method assumes that the fate and transport processes of VOCs in vadose zone have reached steady state. However, because PCBs have significantly higher soil sorption, the transport of PCBs in vadose zone soil is highly retarded. As a result, the PCB concentrations in vadose zone soil between the source and groundwater table tend to be in a transient condition that occurs long after the initial release. In addition, the modification factor due to distance above groundwater in the AF Method is based on an assumed linear relationship between AF and the distance above groundwater. The linear relationship in the Los Angeles RWQCB guidance document is based on a study of VOC downward transport using a one-dimensional vadose zone transport model, VLEACH (Ravi and Johnson, 1994).[3] Because PCBs have a significantly higher soil sorption than the VOCs, the relationship between AF and the distance above groundwater is likely very different from the relationship used in the AF Method. Without establishing this relationship for PCBs using the VLEACH model, the AF Method is inappropriate to use for PCBs. Instead, numerical simulations were performed to simulate the fate and

[3] Ravi, V. and J.A. Johnson, 1994, VLEACH (version 2.1), Center for Subsurface Modeling Support, Robert Kerr Environmental Research Laboratory, Ada, Oklahoma.

transport of PCBs in a one-dimensional soil column in the vadose zone. The model developed for PCB attenuation analysis is described below.

The modeling was performed using commercial software, MODFLOW-SURFACT (HydroGeologic, Inc., 2006),[4] which is similar to VLEACH. The code for this software is based on the most commonly used groundwater modeling software, MODFLOW (Harbaugh et.al, 2000),[5] released by the United States Geological Survey. The MODFLOW-SURFACT code has an additional capability to simulate the moisture movement as well as the fate and transport of chemicals in the vadose zone using the Van Genuchten's model. This code was selected because it was supported by a commonly used MODFLOW pre- and post-processing graphical user interface software, Groundwater Vista®, which was released by Environmental Simulation, Inc. (2007).[6]

2.1 MODEL CONSTRUCTION AND PARAMETERS

A one-dimensional MODFLOW-SURFACT model was constructed to simulate a one-dimensional soil column. The model domain consisted of one row and one column. Vertically, the model has thirty layers with a uniform thickness of 5 feet to represent the vadose zone and one layer with a thickness of 50 feet to represent the saturated zone. The groundwater table was assumed to be at 150 feet below ground surface (bgs).

The lithologic profile used in the MODFLOW-SURFACT model was based on the logs of on-site Borings 125 and 126; the lithologic profile developed from these two borings was considered representative of site-wide conditions. The hydrogeologic parameters and Van Genuchten's model parameters for each layer were obtained using the computer code ROSETTA (version 1.2) developed by the Salinity Laboratory of the United States Department of Agriculture (2000).[7] The inputs to the ROSETTA code are the percentage of sand, silt, and clay in each layer. For each boring, the percentages of gravel, sand, silt, and clay in 5-foot intervals between the ground

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[4] HydroGeologic, Inc., 2006, MODFLOW-SURFACT (version 3.0), Reston, Virginia, May.
[5] Harbaugh, A.W., E.R. Banta, M.C. Hill, and M.G. McDonald, 2000, MODFLOW-2000, The U.S. Geological Survey Modular Ground-water Model – User Guide to Modularization Concepts and the Ground-Water Flow Process: U.S. Geological Survey Open-File Report 00-92, p. 121.
[6] Environmental Simulation, Inc., 2007, Groundwater Vista (version 5.01), Reinholds, Pennsylvania, June.
[7] United States Salinity Laboratory, 2000, ROSETTA (version 2.1), Agricultural Research Service, United States Department of Agriculture, November.

surface and the groundwater table were estimated. The percentage of gravel is combined with the percentage of sand as the ROSETTA does not accept percentage of gravel as an input. The percentages in the same interval for the two borings were then averaged to obtain average percentages as input to ROSETTA. In the MODFLOW-SURFACT model for crushed concrete, the hydrogeologic parameters and Van Genuchten's model parameters for 100% sand were used for the top 15 feet of vadose soil to represent the crushed concrete as fill.

The other model parameters are listed below.

- Soil bulk density, ρ = 96 pounds per cubic feet
- Porosity, n = 0.40
- Soil organic carbon content, f_{oc} = 0.39%
- Sorption partition coefficient for PCBs, K_{oc} = 309,000 liters per kilogram

Site-specific soil physical properties were based on the field investigations of the Morrison Knudsen Corporation (1995).[8] The effective porosity value in the model is assumed to be 40 percent, based on an average porosity value of 47 percent. The sorption partition coefficient for PCBs was obtained from U.S. EPA guidance (1996).[9] The dispersivity in the model is assumed to be equal to 15 feet, 10 percent of the simulated distance between PCB source and groundwater table (150 feet).

Infiltration was applied to the uppermost model layer. An average infiltration rate of 4 inches per year was assumed. The 4 inches per year infiltration rate is approximately equal to 25 percent of the average precipitation in the site area, and is considered conservative for a largely paved or vegetated land surface. The average total annual precipitation at a weather station near the city of Vernon from 1914 to 2007 is 14.8 inches per year.[10] As a reference, if the infiltration rate is calculated using the recharge model of Williamson et al., 1989,[11]

[8] Morrison Knudsen Corporation, 1995, Final Report Stoddard Solvent System Field Investigation, Aluminum Company of America, October 27.
[9] U.S. EPA, 1996, Soil Screening Guidance: Users Guide and Technical Background Document, Office of Solid Waste and Emergency Response, Washington, D.C., EPA/540/R-95/128, May.
[10] Western Regional Climate Center, http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca5115.
[11] Williamson, A.K., D.E. Prudic, and L.A. Swain, 1989, Ground-water flow in the Central Valley, California, U.S. Geological Survey Professional Paper 1401-D.

$$R = \max[(0.64 \times P - 9.1), 0]$$

where, R = infiltration rate (inches/year)

P = precipitation (inches/year)

the infiltration rate is approximately 0.4 inches per year. A study of infiltration rates in the Riverside County, which has similar meteorological condition as the site, by USGS also suggested that the land surface infiltration rate is much less than 25% of precipitation.[12] Therefore, the infiltration rate of 4 inches per year is a conservative assumption, even for an unpaved land surface. A constant head boundary with the specified head equal to the elevation of the top of the bottom layer was applied at the bottom layer to represent the groundwater table elevation in the saturated zone.

The model is run in transient mode for a period of 500 years. There are 50 stress periods, each of which is 10 years long and divided into 120 monthly time steps.

2.2 SIMULATIONS

Two separate simulations, one for PCBs in soil and another for PCBs in concrete (assumed to be crushed and re-used as fill on-site), were conducted to evaluate if the detected concentrations in either medium pose a threat to groundwater quality. Specifically, the simulations were used to estimate site-specific attenuation factors for PCBs, which were then used in reverse calculations from the groundwater MCL to calculate the concentrations that would be necessary in the vadose zone to pose a potential threat to groundwater.

2.2.1 PCBs in Soil

The MODFLOW-SURFACT model described above was used to estimate site-specific attenuation factors for PCBs in soil at hypothetical source depths of 15 feet, 30 feet, and 45 feet bgs. These attenuation factors were estimated by having the MODFLOW-SURFACT model simulate the movement of PCBs in pore water from these depths to pore water immediately above the water table (at approximately 150 feet bgs) after 500 years. A constant PCB concentration in pore water of 100 micrograms per liter (µg/L) was assumed at each source depth for the simulations. The attenuation factors were then calculated as the ratios of the source pore water concentration (100 µg/L) to

[12] USGS, Rainfall-Runoff Characteristics and Effects of Increased Urban Density on Streamflow and Infiltration in Eastern Part of the San Jacinto River Basin, Riverside County, California, USGS Water-Resources Investigations Report 02-4090.

the simulated pore water concentrations immediately above the water table. All calculations using the MODFLOW-SURFACT simulation results were implemented in Mathcad® (version 14; Parametric Technology Corporation, 2007) (Worksheet D-15).

For the hypothetical source depths of 15 and 30 feet bgs, the simulated pore water concentrations immediately above the water table were below the lowest value that the MODFLOW-SURFACT could report ($1x10^{-44}$ µg/L). The minimum reportable concentration ($1x10^{-44}$ µg/L) was therefore used as the simulated pore water concentration immediately above the water table in calculating the attenuation factors for these two cases. As the pore water concentrations immediately above the water table would actually be lower than this minimum reportable value, the simulated attenuation is actually higher than the results would indicate.

As presented in Worksheet D-15, the attenuation factors calculated using this method ranged from $2.2x10^{44}$ to $1x10^{46}$ for source depths of 15 to 45 feet bgs. These attenuation factors are conservative because the dilution of PCBs after entering the saturated zone and the degradation of PCBs in the vadose zone are not considered in the MODFLOW-SURFACT model. These attenuation factors were then used in a reverse calculation from the MCL, 0.5 µg/L, to estimate the source pore water concentrations at 15 feet, 30 feet, and 45 feet bgs that would be necessary to pose a potential threat to groundwater quality. The estimated source pore water concentrations ranged from $1.1x10^{41}$ to $5x10^{42}$ milligrams per liter (mg/L) (Worksheet D-15). Based on these calculations, the concentration of PCBs in source pore water at the Site would need to exceed $1.1x10^{41}$ mg/L at 45 feet bgs or $5x10^{42}$ mg/L at 15 to 30 feet bgs to result in groundwater concentrations exceeding the MCL. Because these concentrations greatly exceed the solubility limit of PCBs in water (0.7 mg/L; U.S. EPA, 1996) and exceeds the concentration of pure phase PCBs ($1x10^{6}$ mg/L), it is physically impossible to achieve PCB concentrations in the source pore water that would result in a concentration of PCBs exceeding the MCL in groundwater. Therefore, PCBs in soil at the Site do not pose a potential threat to groundwater at the Site.

2.3.2 PCBs in Crushed Concrete

Because crushed concrete containing PCBs may be re-used as on-site fill materials within the upper 15 feet of the vadose zone, the reverse calculation method described above was also used to verify that PCBs in re-used crushed concrete do not pose a potential threat to groundwater quality. The MODFLOW-SURFACT simulation was performed in the same manner as described above for soil, but modified to account for the physical properties associated with crushed concrete. For crushed concrete, sand (approximating the properties for crushed concrete) was used for the hydrogeologic parameters and Van Genuchten's model parameters rather than the lithologic parameters estimated for the upper 15 feet of the soil column. An attenuation factor was then estimated for PCBs from a source depth of 15 feet bgs, corresponding to the bottom depth of proposed concrete re-use. As presented in Worksheet D-16, the attenuation factor estimated for the concrete re-use scenario was 1×10^{46}, equal to the attenuation factor estimated for PCBs in native soil at 15 or 30 feet bgs (Worksheet D-15). Correspondingly, the source pore water concentration of PCBs dissolved from crushed concrete at 15 feet bgs would need to exceed 5×10^{42} mg/L to result in groundwater concentrations exceeding the MCL. As noted earlier for soil, these concentrations greatly exceed the solubility limit of PCBs in water (0.7 mg/L; U.S. EPA, 1996) and exceed the concentration of pure phase PCBs (1×10^{6} mg/L), and therefore it is physically impossible to achieve PCB concentrations in the source pore water from the crushed concrete that would result in a concentration of PCBs exceeding the MCL in groundwater. Therefore, PCBs in concrete that may be re-used as on-site fill materials also do not pose a potential threat to groundwater at the Site.

Worksheet D-1
Site-specific Soil Screening Levels for the Protection of Groundwater - TCE

Project Number 010627.003.0

Calculated by: Miao Zhang
Date: December 19, 2007

The following calculation is based on Appendix A (referred to as Appendix A in this calculation), "Attenuation Factor Method For VOCs" of "Interim Site Assessment & Cleanup Guidebook" published by the California Regional Water Quality Control Board, Los Angeles Region (referred to as the LARWQCB method in this calculation).

1. Maximum Attenuation Factor (AFmax)

- maximum attenuation factor $AFmax := 145$ (Table 2 of Appendix A)

2. Modification Factor Due to Distance Above Groundwater (AFD)

- depth to groundwater = $DT := 150ft$

$i := 1 .. 149$

depth to water from point of Interst = $D_i := DT - i \cdot ft$

$$AFD_i := \begin{cases} \max(1, AFmax) & \text{if } D_i > 150ft \\ \max\left[1, \left(0.9\frac{D_i - 40ft}{110ft} + 0.1\right) \cdot AFmax\right] & \text{if } 40ft < D_i \le 150ft \\ \max\left[1, \frac{D_i}{40ft} \cdot (0.1AFmax - 1) + 1\right] & \text{if } D_i \le 40ft \end{cases}$$

(Equations 5-7 of Appendix A)

3. Total Modification Factor Due to Distance Above Groundwater and Lithology (AFT)

- boring information::

$i := 1 .. 150$

$GR125_i := 0$ $SA125_i := 0$ $SI125_i := 0$ $CL125_i := 0$

$GR126_i := 0$ $SA126_i := 0$ $SI126_i := 0$ $CL126_i := 0$

Boring No. 125

1' - 15': Silty Sand	$i := 1..15$	$SA125_i := 1$
15' - 19': Poorly Graded Sand	$i := 16..19$	$SA125_i := 1$
19' - 25': Silty Sand	$i := 20..25$	$SA125_i := 1$
25' - 47': Poorly Graded Sand	$i := 26..47$	$SA125_i := 1$
47' - 48': Sandy Silt	$i := 48..48$	$SI125_i := 1$
48' - 54': Silty Sand	$i := 49..54$	$SA125_i := 1$
54' - 64': Lean Clay	$i := 55..64$	$CL125_i := 1$
64' - 80': Poorly Graded Sand	$i := 65..80$	$SA125_i := 1$
80' - 85': Sandy Silt	$i := 81..85$	$SI125_i := 1$
85' - 89': Sandy Lean Clay	$i := 86..89$	$CL125_i := 1$
89' - 106': Poorly Graded Sand	$i := 90..106$	$SA125_i := 1$
106' - 114': Sandy Silt	$i := 107..114$	$SI125_i := 1$
114 - 121': Poorly Graded Sand	$i := 115..121$	$SA125_i := 1$
121 - 125': Silty Sand	$i := 122..125$	$SA125_i := 1$
125' - 144': Poorly Graded Sand	$i := 126..144$	$SA125_i := 1$
144' - 145': Silt	$i := 145..145$	$SI125_i := 1$
145' - 150': Poorly Graded Sand	$i := 146..150$	$SA125_i := 1$

Boring No. 126

1' - 8': Silty Sand	$i := 1..8$	$SA126_i := 1$
8' - 46': Poorly Graded Sand	$i := 9..46$	$SA126_i := 1$
46' - 51': Silty Sand	$i := 47..51$	$SA126_i := 1$
51' - 53': Silt	$i := 52..53$	$SI126_i := 1$
53' - 63': Lean Clay	$i := 54..63$	$CL126_i := 1$
63' - 69': Silty Sand	$i := 64..69$	$SA126_i := 1$
69' - 104': Poorly Graded Sand	$i := 70..104$	$SA126_i := 1$
104' - 111': Lean Clay	$i := 105..111$	$CL126_i := 1$
111' - 121': Poorly Graded Sand	$i := 112..121$	$SA126_i := 1$
121' - 125: Lean Clay	$i := 122..125$	$CL126_i := 1$
125 - 135: Poorly Graded Sand	$i := 126..135$	$SA126_i := 1$
135 - 140': Silty Sand	$i := 136..140$	$SA126_i := 1$
140' - 150': Poorly Graded Sand	$i := 141..150$	$SA126_i := 1$

$$i := 1 .. 149$$

$$TGR_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} GR125_j + \sum_{j=i+1}^{\frac{DT}{ft}} GR126_j\right)$$

$$TSA_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} SA125_j + \sum_{j=i+1}^{\frac{DT}{ft}} SA126_j\right)$$

$$TSI_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} SI125_j + \sum_{j=i+1}^{\frac{DT}{ft}} SI126_j\right)$$

$$TCL_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} CL125_j + \sum_{j=i+1}^{\frac{DT}{ft}} CL126_j\right)$$

$$AFT_i := \max\left[1, \frac{AFD_i}{\frac{D_i}{ft}}\cdot\left(\frac{TGR_i}{20} + \frac{TSA_i}{10} + \frac{TSI_i}{5} + \frac{TCL_i}{1}\right)\right]$$ (Equation 12 of Appendix A)

4. Use of Attenuation Factor for Soil Screening Levels

- maximum contaminant level $MCL := 0.005$ (California MCL, in ppm)

$$i := 1 .. 149$$

$$conc_i := AFT_i \cdot MCL$$ (Equation 13 of Appendix A)

depth of point of interest: $depth_i := -i\cdot ft$

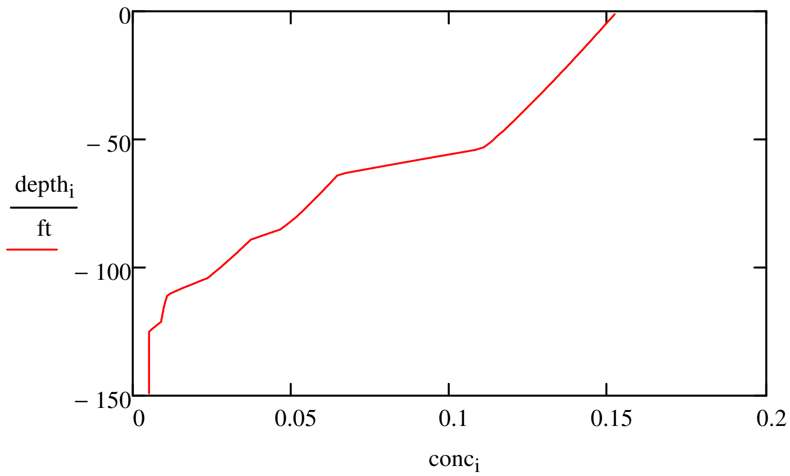

Figure 1. Soil Screening Levels (in ppm) at Various Depths from Ground Surface

TCE.xls

conc

Worksheet D-2
Site-specific Soil Screening Levels for the Protection of Groundwater - PCE

Project Number 010627.003.0

Calculated by: Miao Zhang
Date: December 19, 2007

The following calculation is based on Appendix A (referred to as Appendix A in this calculation), "Attenuation Factor Method For VOCs" of "Interim Site Assessment & Cleanup Guidebook" published by the California Regional Water Quality Control Board, Los Angeles Region (referred to as the LARWQCB method in this calculation).

1. Maximum Attenuation Factor (AFmax)

- maximum attenuation factor $AFmax := 729$ (Table 2 of Appendix A)

2. Modification Factor Due to Distance Above Groundwater (AFD)

- depth to groundwater = $DT := 150ft$

$i := 1..149$

depth to water from point of Interst = $D_i := DT - i \cdot ft$

$$AFD_i := \begin{cases} \max(1, AFmax) & \text{if } D_i > 150ft \\ \max\left[1, \left(0.9\dfrac{D_i - 40ft}{110ft} + 0.1\right) \cdot AFmax\right] & \text{if } 40ft < D_i \le 150ft \\ \max\left[1, \dfrac{D_i}{40ft} \cdot (0.1AFmax - 1) + 1\right] & \text{if } D_i \le 40ft \end{cases}$$

(Equations 5-7 of Appendix A)

3. Total Modification Factor Due to Distance Above Groundwater and Lithology (AFT)

- boring information::

$i := 1..150$

$GR125_i := 0 \quad SA125_i := 0 \quad SI125_i := 0 \quad CL125_i := 0$

$GR126_i := 0 \quad SA126_i := 0 \quad SI126_i := 0 \quad CL126_i := 0$

Boring No. 125

1' - 15': Silty Sand	$i := 1..15$	$SA125_i := 1$
15' - 19': Poorly Graded Sand	$i := 16..19$	$SA125_i := 1$
19' - 25': Silty Sand	$i := 20..25$	$SA125_i := 1$
25' - 47': Poorly Graded Sand	$i := 26..47$	$SA125_i := 1$
47' - 48': Sandy Silt	$i := 48..48$	$SI125_i := 1$
48' - 54': Silty Sand	$i := 49..54$	$SA125_i := 1$
54' - 64': Lean Clay	$i := 55..64$	$CL125_i := 1$
64' - 80': Poorly Graded Sand	$i := 65..80$	$SA125_i := 1$
80' - 85': Sandy Silt	$i := 81..85$	$SI125_i := 1$
85' - 89': Sandy Lean Clay	$i := 86..89$	$CL125_i := 1$
89' - 106': Poorly Graded Sand	$i := 90..106$	$SA125_i := 1$
106' - 114': Sandy Silt	$i := 107..114$	$SI125_i := 1$
114 - 121': Poorly Graded Sand	$i := 115..121$	$SA125_i := 1$
121 - 125': Silty Sand	$i := 122..125$	$SA125_i := 1$
125' - 144': Poorly Graded Sand	$i := 126..144$	$SA125_i := 1$
144' - 145': Silt	$i := 145..145$	$SI125_i := 1$
145' - 150': Poorly Graded Sand	$i := 146..150$	$SA125_i := 1$

Boring No. 126

1' - 8': Silty Sand	$i := 1..8$	$SA126_i := 1$
8' - 46': Poorly Graded Sand	$i := 9..46$	$SA126_i := 1$
46' - 51': Silty Sand	$i := 47..51$	$SA126_i := 1$
51' - 53': Silt	$i := 52..53$	$SI126_i := 1$
53' - 63': Lean Clay	$i := 54..63$	$CL126_i := 1$
63' - 69': Silty Sand	$i := 64..69$	$SA126_i := 1$
69' - 104': Poorly Graded Sand	$i := 70..104$	$SA126_i := 1$
104' - 111': Lean Clay	$i := 105..111$	$CL126_i := 1$
111' - 121': Poorly Graded Sand	$i := 112..121$	$SA126_i := 1$
121' - 125: Lean Clay	$i := 122..125$	$CL126_i := 1$
125 - 135: Poorly Graded Sand	$i := 126..135$	$SA126_i := 1$
135 - 140': Silty Sand	$i := 136..140$	$SA126_i := 1$
140' - 150': Poorly Graded Sand	$i := 141..150$	$SA126_i := 1$

$i := 1 .. 149$

$$TGR_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} GR125_j + \sum_{j=i+1}^{\frac{DT}{ft}} GR126_j\right)$$

$$TSA_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} SA125_j + \sum_{j=i+1}^{\frac{DT}{ft}} SA126_j\right)$$

$$TSI_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} SI125_j + \sum_{j=i+1}^{\frac{DT}{ft}} SI126_j\right)$$

$$TCL_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} CL125_j + \sum_{j=i+1}^{\frac{DT}{ft}} CL126_j\right)$$

$$AFT_i := \max\left[1, \frac{AFD_i}{\frac{D_i}{ft}} \cdot \left(\frac{TGR_i}{20} + \frac{TSA_i}{10} + \frac{TSI_i}{5} + \frac{TCL_i}{1}\right)\right]$$ (Equation 12 of Appendix A)

4. Use of Attenuation Factor for VOC Soil Screening Levels

- maximum contaminant level $MCL := 0.005$ (California MCL, in ppm)

$i := 1 .. 149$

$conc_i := AFT_i \cdot MCL$ (Equation 13 of Appendix A)

depth of point of interest: $depth_i := -i \cdot ft$

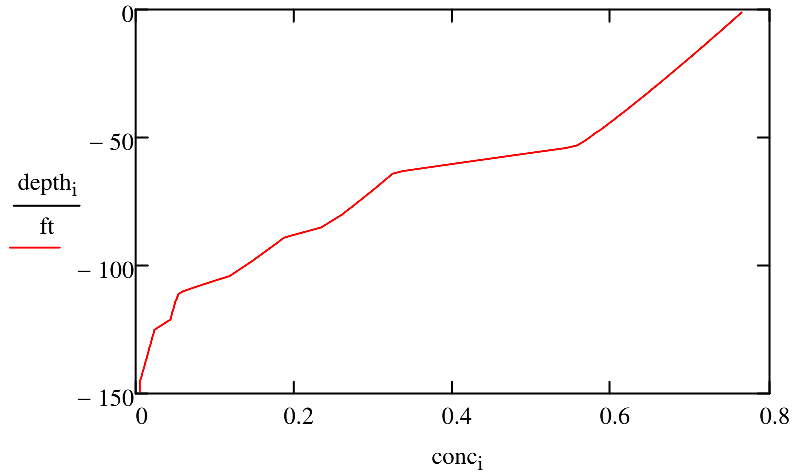

Figure 1. Soil Screening Levels (in ppm) at Various Depths from Ground Surface

PCE.xls

conc

Worksheet D-3
Site-specific Soil Screening Levels for the Protection of Groundwater - Benzene

Project Number 010627.003.0

Calculated by: Miao Zhang
Date: June 26, 2007
Revision: December 17,2007

The following calculation is based on Appendix A (referred to as Appendix A in this calculation), "Attenuation Factor Method For VOCs" of "Interim Site Assessment & Cleanup Guidebook" published by the California Regional Water Quality Control Board, Los Angeles Region (referred to as the LARWQCB method in this calculation).

1. Maximum Attenuation Factor (AFmax)

- maximum attenuation factor $\quad AFmax := 73 \quad$ (Table 2 of Appendix A)

2. Modification Factor Due to Distance Above Groundwater (AFD)

- depth to groundwater = $\quad DT := 150ft$

$i := 1..149$

depth to water from point of Interst = $\quad D_i := DT - i \cdot ft$

$$AFD_i := \begin{cases} \max(1, AFmax) & \text{if } D_i > 150ft \\ \max\left[1, \left(0.9\frac{D_i - 40ft}{110ft} + 0.1\right)\cdot AFmax\right] & \text{if } 40ft < D_i \le 150ft \\ \max\left[1, \frac{D_i}{40ft}\cdot(0.1AFmax - 1) + 1\right] & \text{if } D_i \le 40ft \end{cases}$$

(Equations 5-7 of Appendix A)

3. Total Modification Factor Due to Distance Above Groundwater and Lithology (AFT)

- boring information::

$i := 1..150$

$GR125_i := 0 \quad SA125_i := 0 \quad SI125_i := 0 \quad CL125_i := 0$

$GR126_i := 0 \quad SA126_i := 0 \quad SI126_i := 0 \quad CL126_i := 0$

Boring No. 125

1' - 15': Silty Sand	$i := 1..15$	$SA125_i := 1$
15' - 19': Poorly Graded Sand	$i := 16..19$	$SA125_i := 1$
19' - 25': Silty Sand	$i := 20..25$	$SA125_i := 1$
25' - 47': Poorly Graded Sand	$i := 26..47$	$SA125_i := 1$
47' - 48': Sandy Silt	$i := 48..48$	$SI125_i := 1$
48' - 54': Silty Sand	$i := 49..54$	$SA125_i := 1$
54' - 64': Lean Clay	$i := 55..64$	$CL125_i := 1$
64' - 80': Poorly Graded Sand	$i := 65..80$	$SA125_i := 1$
80' - 85': Sandy Silt	$i := 81..85$	$SI125_i := 1$
85' - 89': Sandy Lean Clay	$i := 86..89$	$CL125_i := 1$
89' - 106': Poorly Graded Sand	$i := 90..106$	$SA125_i := 1$
106' - 114': Sandy Silt	$i := 107..114$	$SI125_i := 1$
114 - 121': Poorly Graded Sand	$i := 115..121$	$SA125_i := 1$
121 - 125': Silty Sand	$i := 122..125$	$SA125_i := 1$
125' - 144': Poorly Graded Sand	$i := 126..144$	$SA125_i := 1$
144' - 145': Silt	$i := 145..145$	$SI125_i := 1$
145' - 150': Poorly Graded Sand	$i := 146..150$	$SA125_i := 1$

Boring No. 126

1' - 8': Silty Sand	$i := 1..8$	$SA126_i := 1$
8' - 46': Poorly Graded Sand	$i := 9..46$	$SA126_i := 1$
46' - 51': Silty Sand	$i := 47..51$	$SA126_i := 1$
51' - 53': Silt	$i := 52..53$	$SI126_i := 1$
53' - 63': Lean Clay	$i := 54..63$	$CL126_i := 1$
63' - 69': Silty Sand	$i := 64..69$	$SA126_i := 1$
69' - 104': Poorly Graded Sand	$i := 70..104$	$SA126_i := 1$
104' - 111': Lean Clay	$i := 105..111$	$CL126_i := 1$
111' - 121': Poorly Graded Sand	$i := 112..121$	$SA126_i := 1$
121' - 125: Lean Clay	$i := 122..125$	$CL126_i := 1$
125 - 135: Poorly Graded Sand	$i := 126..135$	$SA126_i := 1$
135 - 140': Silty Sand	$i := 136..140$	$SA126_i := 1$
140' - 150': Poorly Graded Sand	$i := 141..150$	$SA126_i := 1$

$$i := 1 .. 149$$

$$TGR_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} GR125_j + \sum_{j=i+1}^{\frac{DT}{ft}} GR126_j\right)$$

$$TSA_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} SA125_j + \sum_{j=i+1}^{\frac{DT}{ft}} SA126_j\right)$$

$$TSI_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} SI125_j + \sum_{j=i+1}^{\frac{DT}{ft}} SI126_j\right)$$

$$TCL_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} CL125_j + \sum_{j=i+1}^{\frac{DT}{ft}} CL126_j\right)$$

$$AFT_i := \max\left[1, \frac{AFD_i}{\frac{D_i}{ft}} \cdot \left(\frac{TGR_i}{20} + \frac{TSA_i}{10} + \frac{TSI_i}{5} + \frac{TCL_i}{1}\right)\right]$$ (Equation 12 of Appendix A)

4. Use of Attenuation Factor for VOC Soil Screening Levels

- maximum contaminant level $MCL := 0.001$ (California MCL, in ppm)

$$i := 1 .. 149$$

$$conc_i := AFT_i \cdot MCL$$ (Equation 13 of Appendix A)

depth of point of interest: $depth_i := -i \cdot ft$

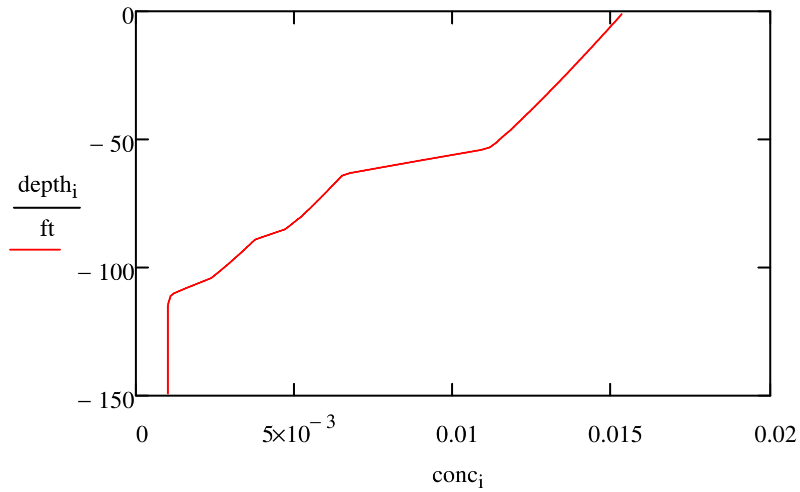

Figure 1. Soil Screening Levels (in ppm) at Various Depths from Ground Surface

benzene.xls

conc

Worksheet D-4
Site-specific Soil Screening Levels for the Protection of Groundwater - Toluene

Project Number 010627.003.0

Calculated by: Miao Zhang
Date: June 26, 2007
Revision: December 17, 2007

The following calculation is based on Appendix A (referred to as Appendix A in this calculation), "Attenuation Factor Method For VOCs" of "Interim Site Assessment & Cleanup Guidebook" published by the California Regional Water Quality Control Board, Los Angeles Region (referred to as the LARWQCB method in this calculation).

1. Maximum Attenuation Factor (AFmax)

- maximum attenuation factor $\quad AFmax := 288 \quad$ (Table 2 of Appendix A)

2. Modification Factor Due to Distance Above Groundwater (AFD)

- depth to groundwater = $\quad DT := 150ft$

$i := 1..149$

depth to water from point of Interst = $\quad D_i := DT - i \cdot ft$

$$AFD_i := \begin{vmatrix} \max(1, AFmax) \quad \text{if } D_i > 150ft \\ \max\left[1, \left(0.9\dfrac{D_i - 40ft}{110ft} + 0.1\right) \cdot AFmax\right] \quad \text{if } 40ft < D_i \le 150ft \\ \max\left[1, \dfrac{D_i}{40ft} \cdot (0.1AFmax - 1) + 1\right] \quad \text{if } D_i \le 40ft \end{vmatrix}$$

(Equations 5-7 of Appendix A)

3. Total Modification Factor Due to Distance Above Groundwater and Lithology (AFT)

- boring information::

$i := 1..150$

$GR125_i := 0 \quad SA125_i := 0 \quad SI125_i := 0 \quad CL125_i := 0$

$GR126_i := 0 \quad SA126_i := 0 \quad SI126_i := 0 \quad CL126_i := 0$

Boring No. 125

1' - 15': Silty Sand	$i := 1..15$	$SA125_i := 1$
15' - 19': Poorly Graded Sand	$i := 16..19$	$SA125_i := 1$
19' - 25': Silty Sand	$i := 20..25$	$SA125_i := 1$
25' - 47': Poorly Graded Sand	$i := 26..47$	$SA125_i := 1$
47' - 48': Sandy Silt	$i := 48..48$	$SI125_i := 1$
48' - 54': Silty Sand	$i := 49..54$	$SA125_i := 1$
54' - 64': Lean Clay	$i := 55..64$	$CL125_i := 1$
64' - 80': Poorly Graded Sand	$i := 65..80$	$SA125_i := 1$
80' - 85': Sandy Silt	$i := 81..85$	$SI125_i := 1$
85' - 89': Sandy Lean Clay	$i := 86..89$	$CL125_i := 1$
89' - 106': Poorly Graded Sand	$i := 90..106$	$SA125_i := 1$
106' - 114': Sandy Silt	$i := 107..114$	$SI125_i := 1$
114 - 121': Poorly Graded Sand	$i := 115..121$	$SA125_i := 1$
121 - 125': Silty Sand	$i := 122..125$	$SA125_i := 1$
125' - 144': Poorly Graded Sand	$i := 126..144$	$SA125_i := 1$
144' - 145': Silt	$i := 145..145$	$SI125_i := 1$
145' - 150': Poorly Graded Sand	$i := 146..150$	$SA125_i := 1$

Boring No. 126

1' - 8': Silty Sand	$i := 1..8$	$SA126_i := 1$
8' - 46': Poorly Graded Sand	$i := 9..46$	$SA126_i := 1$
46' - 51': Silty Sand	$i := 47..51$	$SA126_i := 1$
51' - 53': Silt	$i := 52..53$	$SI126_i := 1$
53' - 63': Lean Clay	$i := 54..63$	$CL126_i := 1$
63' - 69': Silty Sand	$i := 64..69$	$SA126_i := 1$
69' - 104': Poorly Graded Sand	$i := 70..104$	$SA126_i := 1$
104' - 111': Lean Clay	$i := 105..111$	$CL126_i := 1$
111' - 121': Poorly Graded Sand	$i := 112..121$	$SA126_i := 1$
121' - 125: Lean Clay	$i := 122..125$	$CL126_i := 1$
125 - 135: Poorly Graded Sand	$i := 126..135$	$SA126_i := 1$
135 - 140': Silty Sand	$i := 136..140$	$SA126_i := 1$
140' - 150': Poorly Graded Sand	$i := 141..150$	$SA126_i := 1$

$i := 1..149$

$$TGR_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} GR125_j + \sum_{j=i+1}^{\frac{DT}{ft}} GR126_j\right)$$

$$TSA_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} SA125_j + \sum_{j=i+1}^{\frac{DT}{ft}} SA126_j\right)$$

$$TSI_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} SI125_j + \sum_{j=i+1}^{\frac{DT}{ft}} SI126_j\right)$$

$$TCL_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} CL125_j + \sum_{j=i+1}^{\frac{DT}{ft}} CL126_j\right)$$

$$AFT_i := \max\left[1, \frac{AFD_i}{\frac{D_i}{ft}} \cdot \left(\frac{TGR_i}{20} + \frac{TSA_i}{10} + \frac{TSI_i}{5} + \frac{TCL_i}{1}\right)\right]$$ (Equation 12 of Appendix A)

4. Use of Attenuation Factor for VOC Soil Screening Levels

- maximum contaminant level $MCL := 0.15$ (California MCL, in ppm)

$i := 1..149$

$conc_i := AFT_i \cdot MCL$ (Equation 13 of Appendix A)

depth of point of interest: $depth_i := -i \cdot ft$

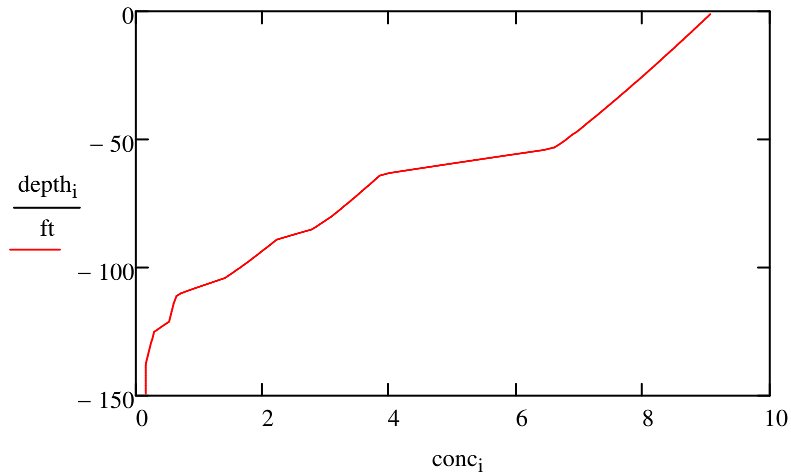

Figure 1. Soil Screening Levels (in ppm) at Various Depths from Ground Surface

toluene.xls

conc

Worksheet D-5
Site-specific Soil Screening Levels for the Protection of Groundwater - Ethylbenzene

Project Number 010627.003.0

Calculated by: Miao Zhang
Date: June 26, 2007
Revision: December 17,2007

The following calculation is based on Appendix A (referred to as Appendix A in this calculation), "Attenuation Factor Method For VOCs" of "Interim Site Assessment & Cleanup Guidebook" published by the California Regional Water Quality Control Board, Los Angeles Region (referred to as the LARWQCB method in this calculation).

1. Maximum Attenuation Factor (AFmax)

- maximum attenuation factor

$AFmax := 244$ (Table 2 of Appendix A)

2. Modification Factor Due to Distance Above Groundwater (AFD)

- depth to groundwater = $DT := 150ft$

$i := 1..149$

depth to water from point of Interst = $D_i := DT - i \cdot ft$

$$AFD_i := \begin{cases} \max(1, AFmax) & \text{if } D_i > 150ft \\ \max\left[1, \left(0.9\dfrac{D_i - 40ft}{110ft} + 0.1\right) \cdot AFmax\right] & \text{if } 40ft < D_i \le 150ft \\ \max\left[1, \dfrac{D_i}{40ft} \cdot (0.1AFmax - 1) + 1\right] & \text{if } D_i \le 40ft \end{cases}$$

(Equations 5-7 of Appendix A)

3. Total Modification Factor Due to Distance Above Groundwater and Lithology (AFT)

- boring information::

$i := 1..150$

$GR125_i := 0 \quad SA125_i := 0 \quad SI125_i := 0 \quad CL125_i := 0$

$GR126_i := 0 \quad SA126_i := 0 \quad SI126_i := 0 \quad CL126_i := 0$

Boring No. 125

1' - 15': Silty Sand	$i := 1..15$	$SA125_i := 1$
15' - 19': Poorly Graded Sand	$i := 16..19$	$SA125_i := 1$
19' - 25': Silty Sand	$i := 20..25$	$SA125_i := 1$
25' - 47': Poorly Graded Sand	$i := 26..47$	$SA125_i := 1$
47' - 48': Sandy Silt	$i := 48..48$	$SI125_i := 1$
48' - 54': Silty Sand	$i := 49..54$	$SA125_i := 1$
54' - 64': Lean Clay	$i := 55..64$	$CL125_i := 1$
64' - 80': Poorly Graded Sand	$i := 65..80$	$SA125_i := 1$
80' - 85': Sandy Silt	$i := 81..85$	$SI125_i := 1$
85' - 89': Sandy Lean Clay	$i := 86..89$	$CL125_i := 1$
89' - 106': Poorly Graded Sand	$i := 90..106$	$SA125_i := 1$
106' - 114': Sandy Silt	$i := 107..114$	$SI125_i := 1$
114 - 121': Poorly Graded Sand	$i := 115..121$	$SA125_i := 1$
121 - 125': Silty Sand	$i := 122..125$	$SA125_i := 1$
125' - 144': Poorly Graded Sand	$i := 126..144$	$SA125_i := 1$
144' - 145': Silt	$i := 145..145$	$SI125_i := 1$
145' - 150': Poorly Graded Sand	$i := 146..150$	$SA125_i := 1$

Boring No. 126

1' - 8': Silty Sand	$i := 1..8$	$SA126_i := 1$
8' - 46': Poorly Graded Sand	$i := 9..46$	$SA126_i := 1$
46' - 51': Silty Sand	$i := 47..51$	$SA126_i := 1$
51' - 53': Silt	$i := 52..53$	$SI126_i := 1$
53' - 63': Lean Clay	$i := 54..63$	$CL126_i := 1$
63' - 69': Silty Sand	$i := 64..69$	$SA126_i := 1$
69' - 104': Poorly Graded Sand	$i := 70..104$	$SA126_i := 1$
104' - 111': Lean Clay	$i := 105..111$	$CL126_i := 1$
111' - 121': Poorly Graded Sand	$i := 112..121$	$SA126_i := 1$
121' - 125: Lean Clay	$i := 122..125$	$CL126_i := 1$
125 - 135: Poorly Graded Sand	$i := 126..135$	$SA126_i := 1$
135 - 140': Silty Sand	$i := 136..140$	$SA126_i := 1$
140' - 150': Poorly Graded Sand	$i := 141..150$	$SA126_i := 1$

$$i := 1 .. 149$$

$$TGR_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} GR125_j + \sum_{j=i+1}^{\frac{DT}{ft}} GR126_j\right)$$

$$TSA_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} SA125_j + \sum_{j=i+1}^{\frac{DT}{ft}} SA126_j\right)$$

$$TSI_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} SI125_j + \sum_{j=i+1}^{\frac{DT}{ft}} SI126_j\right)$$

$$TCL_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} CL125_j + \sum_{j=i+1}^{\frac{DT}{ft}} CL126_j\right)$$

$$AFT_i := \max\left[1, \frac{AFD_i}{\frac{D_i}{ft}} \cdot \left(\frac{TGR_i}{20} + \frac{TSA_i}{10} + \frac{TSI_i}{5} + \frac{TCL_i}{1}\right)\right]$$ (Equation 12 of Appendix A)

4. Use of Attenuation Factor for VOC Soil Screening Levels

- maximum contaminant level $MCL := 0.3$ (California MCL, in ppm)

$$i := 1 .. 149$$

$$conc_i := AFT_i \cdot MCL$$ (Equation 13 of Appendix A)

depth of point of interest: $depth_i := -i \cdot ft$

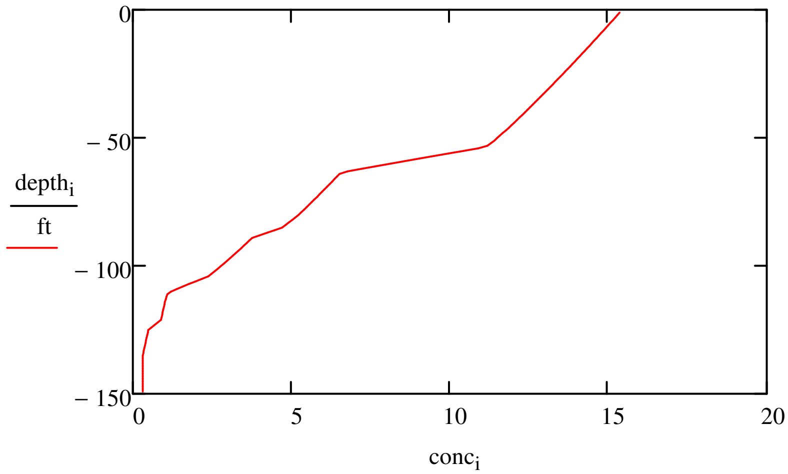

Figure 1. Soil Screening Levels (in ppm) at Various Depths from Ground Surface

ethylbenzene.xls

conc

Worksheet D-6
Site-specific Soil Screening Levels for the Protection of Groundwater - Xylenes

Project Number 010627.003.0

Calculated by: Miao Zhang
Date: June 26, 2007
Revision: December 17, 2007

The following calculation is based on Appendix A (referred to as Appendix A in this calculation), "Attenuation Factor Method For VOCs" of "Interim Site Assessment & Cleanup Guidebook" published by the California Regional Water Quality Control Board, Los Angeles Region (referred to as the LARWQCB method in this calculation).

1. Maximum Attenuation Factor (AFmax)

- maximum attenuation factor $AFmax := 265$ (Table 2 of Appendix A)

2. Modification Factor Due to Distance Above Groundwater (AFD)

- depth to groundwater = $DT := 150ft$

$i := 1..149$

depth to water from point of Interst = $D_i := DT - i \cdot ft$

$$AFD_i := \begin{cases} \max(1, AFmax) & \text{if } D_i > 150ft \\ \max\left[1, \left(0.9\dfrac{D_i - 40ft}{110ft} + 0.1\right) \cdot AFmax\right] & \text{if } 40ft < D_i \le 150ft \\ \max\left[1, \dfrac{D_i}{40ft} \cdot (0.1AFmax - 1) + 1\right] & \text{if } D_i \le 40ft \end{cases}$$

(Equations 5-7 of Appendix A)

3. Total Modification Factor Due to Distance Above Groundwater and Lithology (AFT)

- boring information::

$i := 1..150$

$GR125_i := 0$ $SA125_i := 0$ $SI125_i := 0$ $CL125_i := 0$

$GR126_i := 0$ $SA126_i := 0$ $SI126_i := 0$ $CL126_i := 0$

Boring No. 125

1' - 15': Silty Sand	$i := 1..15$	$SA125_i := 1$
15' - 19': Poorly Graded Sand	$i := 16..19$	$SA125_i := 1$
19' - 25': Silty Sand	$i := 20..25$	$SA125_i := 1$
25' - 47': Poorly Graded Sand	$i := 26..47$	$SA125_i := 1$
47' - 48': Sandy Silt	$i := 48..48$	$SI125_i := 1$
48' - 54': Silty Sand	$i := 49..54$	$SA125_i := 1$
54' - 64': Lean Clay	$i := 55..64$	$CL125_i := 1$
64' - 80': Poorly Graded Sand	$i := 65..80$	$SA125_i := 1$
80' - 85': Sandy Silt	$i := 81..85$	$SI125_i := 1$
85' - 89': Sandy Lean Clay	$i := 86..89$	$CL125_i := 1$
89' - 106': Poorly Graded Sand	$i := 90..106$	$SA125_i := 1$
106' - 114': Sandy Silt	$i := 107..114$	$SI125_i := 1$
114 - 121': Poorly Graded Sand	$i := 115..121$	$SA125_i := 1$
121 - 125': Silty Sand	$i := 122..125$	$SA125_i := 1$
125' - 144': Poorly Graded Sand	$i := 126..144$	$SA125_i := 1$
144' - 145': Silt	$i := 145..145$	$SI125_i := 1$
145' - 150': Poorly Graded Sand	$i := 146..150$	$SA125_i := 1$

Boring No. 126

1' - 8': Silty Sand	$i := 1..8$	$SA126_i := 1$
8' - 46': Poorly Graded Sand	$i := 9..46$	$SA126_i := 1$
46' - 51': Silty Sand	$i := 47..51$	$SA126_i := 1$
51' - 53': Silt	$i := 52..53$	$SI126_i := 1$
53' - 63': Lean Clay	$i := 54..63$	$CL126_i := 1$
63' - 69': Silty Sand	$i := 64..69$	$SA126_i := 1$
69' - 104': Poorly Graded Sand	$i := 70..104$	$SA126_i := 1$
104' - 111': Lean Clay	$i := 105..111$	$CL126_i := 1$
111' - 121': Poorly Graded Sand	$i := 112..121$	$SA126_i := 1$
121' - 125: Lean Clay	$i := 122..125$	$CL126_i := 1$
125 - 135: Poorly Graded Sand	$i := 126..135$	$SA126_i := 1$
135 - 140': Silty Sand	$i := 136..140$	$SA126_i := 1$
140' - 150': Poorly Graded Sand	$i := 141..150$	$SA126_i := 1$

$i := 1..149$

$$TGR_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} GR125_j + \sum_{j=i+1}^{\frac{DT}{ft}} GR126_j\right)$$

$$TSA_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} SA125_j + \sum_{j=i+1}^{\frac{DT}{ft}} SA126_j\right)$$

$$TSI_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} SI125_j + \sum_{j=i+1}^{\frac{DT}{ft}} SI126_j\right)$$

$$TCL_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} CL125_j + \sum_{j=i+1}^{\frac{DT}{ft}} CL126_j\right)$$

$$AFT_i := \max\left[1, \frac{AFD_i}{\frac{D_i}{ft}} \cdot \left(\frac{TGR_i}{20} + \frac{TSA_i}{10} + \frac{TSI_i}{5} + \frac{TCL_i}{1}\right)\right]$$ (Equation 12 of Appendix A)

4. Use of Attenuation Factor for VOC Soil Screening Levels

- maximum contaminant level $MCL := 1.75$ (California MCL, in ppm)

$i := 1..149$

$conc_i := AFT_i \cdot MCL$ (Equation 13 of Appendix A)

depth of point of interest: $depth_i := -i \cdot ft$

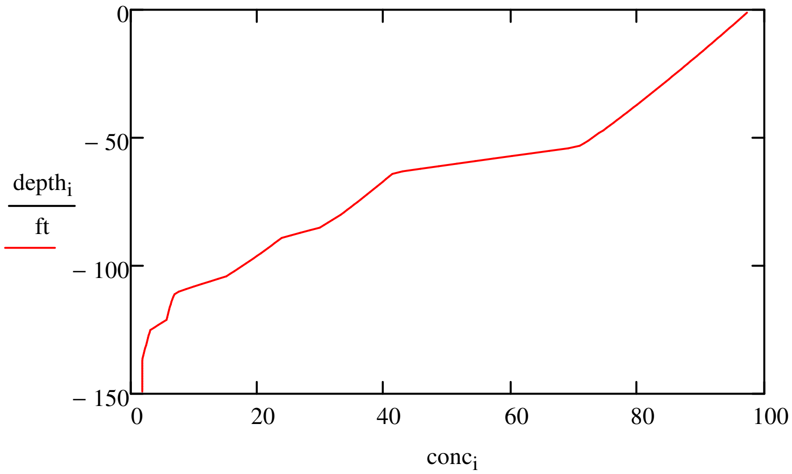

Figure 1. Soil Screening Levels (in ppm) at Various Depths from Ground Surface

xylenes.xls

conc

Worksheet D-7
Site-specific Soil Screening Levels for the Protection of Groundwater - n-Butylbenzene

Project Number 010627.003.0

Calculated by: Miao Zhang
Date: June 26, 2007
Revision: December 17, 2007

The following calculation is based on Appendix A (referred to as Appendix A in this calculation), "Attenuation Factor Method For VOCs" of "Interim Site Assessment & Cleanup Guidebook" published by the California Regional Water Quality Control Board, Los Angeles Region (referred to as the LARWQCB method in this calculation).

1. Maximum Attenuation Factor (AFmax)

- maximum attenuation factor

Non-chemical-specific Parameters

soil bulk density $denb := 2.27 \frac{g}{mL}$

soil water content by volume (dimensionless) $thetaw := 0.031$

soil organic carbon content (dimensionless) $foc := 0.015$

soil porosity (dimensionless) $n := 0.143$

Chemical-specific Parameters

organic carbon partition coefficient $Koc := 2830 \frac{mL}{g}$

Henry's law constant $Kh := 0.537$

Reference: U.S. EPA, 2004, Region IX Preliminary Remediation Goals (PRGs)
http://www.epa.gov/region09/waste/sfund/prg/index.html

Maximum Attenution Factor

$$AFmax := 1 + \left(\frac{denb}{thetaw}\right) \cdot foc \cdot Koc + (n - thetaw) \cdot \frac{Kh}{thetaw}$$ (Equation 4 of Appendix A)

$$AFmax = 3.111 \times 10^{3}$$

2. Modification Factor Due to Distance Above Groundwater (AFD)

- depth to groundwater = $DT := 150ft$

$i := 1 .. 149$

depth to water from point of Interst = $D_i := DT - i \cdot ft$

$$AFD_i := \begin{cases} \max(1, AFmax) & \text{if } D_i > 150ft \\ \max\left[1, \left(0.9\dfrac{D_i - 40ft}{110ft} + 0.1\right) \cdot AFmax\right] & \text{if } 40ft < D_i \le 150ft \\ \max\left[1, \dfrac{D_i}{40ft} \cdot (0.1AFmax - 1) + 1\right] & \text{if } D_i \le 40ft \end{cases}$$

(Equations 5-7 of Appendix A)

3. Total Modification Factor Due to Distance Above Groundwater and Lithology (AFT)

- boring information::

$i := 1..150$

$GR125_i := 0 \quad SA125_i := 0 \quad SI125_i := 0 \quad CL125_i := 0$

$GR126_i := 0 \quad SA126_i := 0 \quad SI126_i := 0 \quad CL126_i := 0$

Boring No. 125

1' - 15': Silty Sand	$i := 1..15$	$SA125_i := 1$
15' - 19': Poorly Graded Sand	$i := 16..19$	$SA125_i := 1$
19' - 25': Silty Sand	$i := 20..25$	$SA125_i := 1$
25' - 47': Poorly Graded Sand	$i := 26..47$	$SA125_i := 1$
47' - 48': Sandy Silt	$i := 48..48$	$SI125_i := 1$
48' - 54': Silty Sand	$i := 49..54$	$SA125_i := 1$
54' - 64': Lean Clay	$i := 55..64$	$CL125_i := 1$
64' - 80': Poorly Graded Sand	$i := 65..80$	$SA125_i := 1$
80' - 85': Sandy Silt	$i := 81..85$	$SI125_i := 1$
85' - 89': Sandy Lean Clay	$i := 86..89$	$CL125_i := 1$
89' - 106': Poorly Graded Sand	$i := 90..106$	$SA125_i := 1$
106' - 114': Sandy Silt	$i := 107..114$	$SI125_i := 1$
114 - 121': Poorly Graded Sand	$i := 115..121$	$SA125_i := 1$
121 - 125': Silty Sand	$i := 122..125$	$SA125_i := 1$
125' - 144': Poorly Graded Sand	$i := 126..144$	$SA125_i := 1$
144' - 145': Silt	$i := 145..145$	$SI125_i := 1$
145' - 150': Poorly Graded Sand	$i := 146..150$	$SA125_i := 1$

Boring No. 126

1' - 8': Silty Sand	$i := 1..8$	$SA126_i := 1$
8' - 46': Poorly Graded Sand	$i := 9..46$	$SA126_i := 1$
46' - 51': Silty Sand	$i := 47..51$	$SA126_i := 1$
51' - 53': Silt	$i := 52..53$	$SI126_i := 1$
53' - 63': Lean Clay	$i := 54..63$	$CL126_i := 1$
63' - 69': Silty Sand	$i := 64..69$	$SA126_i := 1$
69' - 104': Poorly Graded Sand	$i := 70..104$	$SA126_i := 1$
104' - 111': Lean Clay	$i := 105..111$	$CL126_i := 1$
111' - 121': Poorly Graded Sand	$i := 112..121$	$SA126_i := 1$
121' - 125: Lean Clay	$i := 122..125$	$CL126_i := 1$
125 - 135: Poorly Graded Sand	$i := 126..135$	$SA126_i := 1$
135 - 140': Silty Sand	$i := 136..140$	$SA126_i := 1$
140' - 150': Poorly Graded Sand	$i := 141..150$	$SA126_i := 1$

$i := 1..149$

$$TGR_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} GR125_j + \sum_{j=i+1}^{\frac{DT}{ft}} GR126_j\right)$$

$$TSA_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} SA125_j + \sum_{j=i+1}^{\frac{DT}{ft}} SA126_j\right)$$

$$TSI_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} SI125_j + \sum_{j=i+1}^{\frac{DT}{ft}} SI126_j\right)$$

$$TCL_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} CL125_j + \sum_{j=i+1}^{\frac{DT}{ft}} CL126_j\right)$$

$$AFT_i := \max\left[1, \frac{AFD_i}{\frac{D_i}{ft}} \cdot \left(\frac{TGR_i}{20} + \frac{TSA_i}{10} + \frac{TSI_i}{5} + \frac{TCL_i}{1}\right)\right]$$

(Equation 12 of Appendix A)

4. Use of Attenuation Factor for VOC Soil Screening Levels

- water quality objective (WQO) $WQO := 0.26$ (California DHS Notification Level, in ppm)

$i := 1 .. 149$

$conc_i := AFT_i \cdot WQO$ (Equation 13 of Appendix A)

depth of point of interest: $depth_i := -i \cdot ft$

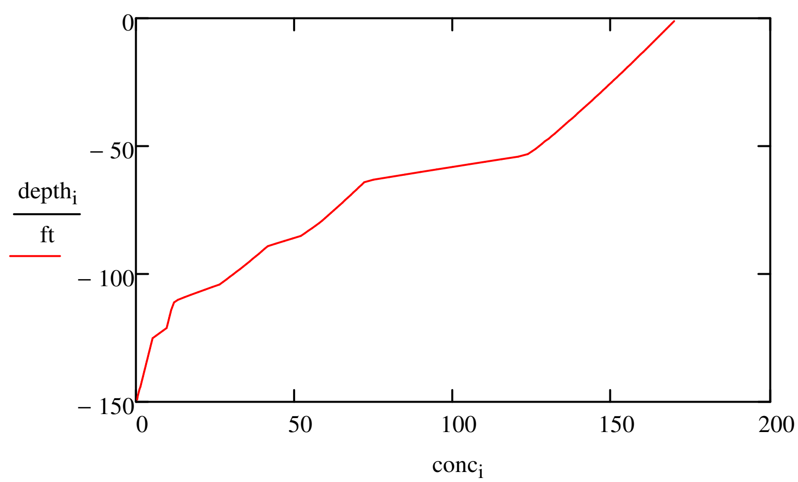

Figure 1. Soil Screening Levels (in ppm) at Various Depths from Ground Surface

n-butylbenzene.xls

conc

Worksheet D-8
Site-specific Soil Screening Levels for the Protection of Groundwater - sec-Butylbenzene

Project Number 010627.003.0

Calculated by: Miao Zhang
Date: June 26, 2007
Revision: December 17, 2007

The following calculation is based on Appendix A (referred to as Appendix A in this calculation), "Attenuation Factor Method For VOCs" of "Interim Site Assessment & Cleanup Guidebook" published by the California Regional Water Quality Control Board, Los Angeles Region (referred to as the LARWQCB method in this calculation).

1. Maximum Attenuation Factor (AFmax)

- maximum attenuation factor

Non-chemical-specific Parameters

soil bulk density $\text{denb} := 2.27 \frac{g}{mL}$

soil water content by volume (dimensionless) $\text{thetaw} := 0.031$

soil organic carbon content (dimensionless) $\text{foc} := 0.015$

soil porosity (dimensionless) $n := 0.143$

Chemical-specific Parameters

organic carbon partition coefficient $\text{Koc} := 2150 \frac{mL}{g}$

Henry's law constant $\text{Kh} := 0.767$

Reference: U.S. EPA, 2004, Region IX Preliminary Remediation Goals (PRGs)
http://www.epa.gov/region09/waste/sfund/prg/index.html

Maximum Attenution Factor

$$\text{AFmax} := 1 + \left(\frac{\text{denb}}{\text{thetaw}}\right)\cdot \text{foc}\cdot \text{Koc} + (n - \text{thetaw})\cdot \frac{\text{Kh}}{\text{thetaw}}$$ (Equation 4 of Appendix A)

$$\text{AFmax} = 2.365 \times 10^{3}$$

2. Modification Factor Due to Distance Above Groundwater (AFD)

- depth to groundwater = $\text{DT} := 150\text{ft}$

$i := 1 .. 149$

depth to water from point of Interst = $D_i := DT - i \cdot ft$

$$AFD_i := \begin{cases} \max(1, AFmax) & \text{if } D_i > 150ft \\ \max\left[1, \left(0.9\dfrac{D_i - 40ft}{110ft} + 0.1\right) \cdot AFmax\right] & \text{if } 40ft < D_i \le 150ft \\ \max\left[1, \dfrac{D_i}{40ft} \cdot (0.1AFmax - 1) + 1\right] & \text{if } D_i \le 40ft \end{cases}$$

(Equations 5-7 of Appendix A)

3. Total Modification Factor Due to Distance Above Groundwater and Lithology (AFT)

- boring information::

$i := 1 .. 150$

$GR125_i := 0 \quad SA125_i := 0 \quad SI125_i := 0 \quad CL125_i := 0$

$GR126_i := 0 \quad SA126_i := 0 \quad SI126_i := 0 \quad CL126_i := 0$

Boring No. 125

1' - 15': Silty Sand	$i := 1 .. 15$	$SA125_i := 1$
15' - 19': Poorly Graded Sand	$i := 16 .. 19$	$SA125_i := 1$
19' - 25': Silty Sand	$i := 20 .. 25$	$SA125_i := 1$
25' - 47': Poorly Graded Sand	$i := 26 .. 47$	$SA125_i := 1$
47' - 48': Sandy Silt	$i := 48 .. 48$	$SI125_i := 1$
48' - 54': Silty Sand	$i := 49 .. 54$	$SA125_i := 1$
54' - 64': Lean Clay	$i := 55 .. 64$	$CL125_i := 1$
64' - 80': Poorly Graded Sand	$i := 65 .. 80$	$SA125_i := 1$
80' - 85': Sandy Silt	$i := 81 .. 85$	$SI125_i := 1$
85' - 89': Sandy Lean Clay	$i := 86 .. 89$	$CL125_i := 1$
89' - 106': Poorly Graded Sand	$i := 90 .. 106$	$SA125_i := 1$
106' - 114': Sandy Silt	$i := 107 .. 114$	$SI125_i := 1$
114 - 121': Poorly Graded Sand	$i := 115 .. 121$	$SA125_i := 1$
121 - 125': Silty Sand	$i := 122 .. 125$	$SA125_i := 1$
125' - 144': Poorly Graded Sand	$i := 126 .. 144$	$SA125_i := 1$
144' - 145': Silt	$i := 145 .. 145$	$SI125_i := 1$
145' - 150': Poorly Graded Sand	$i := 146 .. 150$	$SA125_i := 1$

Boring No. 126

1' - 8': Silty Sand	$i := 1..8$	$SA126_i := 1$
8' - 46': Poorly Graded Sand	$i := 9..46$	$SA126_i := 1$
46' - 51': Silty Sand	$i := 47..51$	$SA126_i := 1$
51' - 53': Silt	$i := 52..53$	$SI126_i := 1$
53' - 63': Lean Clay	$i := 54..63$	$CL126_i := 1$
63' - 69': Silty Sand	$i := 64..69$	$SA126_i := 1$
69' - 104': Poorly Graded Sand	$i := 70..104$	$SA126_i := 1$
104' - 111': Lean Clay	$i := 105..111$	$CL126_i := 1$
111' - 121': Poorly Graded Sand	$i := 112..121$	$SA126_i := 1$
121' - 125: Lean Clay	$i := 122..125$	$CL126_i := 1$
125 - 135: Poorly Graded Sand	$i := 126..135$	$SA126_i := 1$
135 - 140': Silty Sand	$i := 136..140$	$SA126_i := 1$
140' - 150': Poorly Graded Sand	$i := 141..150$	$SA126_i := 1$

$i := 1..149$

$$TGR_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} GR125_j + \sum_{j=i+1}^{\frac{DT}{ft}} GR126_j\right)$$

$$TSA_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} SA125_j + \sum_{j=i+1}^{\frac{DT}{ft}} SA126_j\right)$$

$$TSI_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} SI125_j + \sum_{j=i+1}^{\frac{DT}{ft}} SI126_j\right)$$

$$TCL_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} CL125_j + \sum_{j=i+1}^{\frac{DT}{ft}} CL126_j\right)$$

$$AFT_i := \max\left[1, \frac{AFD_i}{\frac{D_i}{ft}} \cdot \left(\frac{TGR_i}{20} + \frac{TSA_i}{10} + \frac{TSI_i}{5} + \frac{TCL_i}{1}\right)\right]$$ (Equation 12 of Appendix A)

4. Use of Attenuation Factor for VOC Soil Screening Levels

- water quality objective (WQO) $WQO := 0.26$ (California DHS Notification Level, in ppm)

$i := 1 .. 149$

$conc_i := AFT_i \cdot WQO$ (Equation 13 of Appendix A)

depth of point of interest: $depth_i := -i \cdot ft$

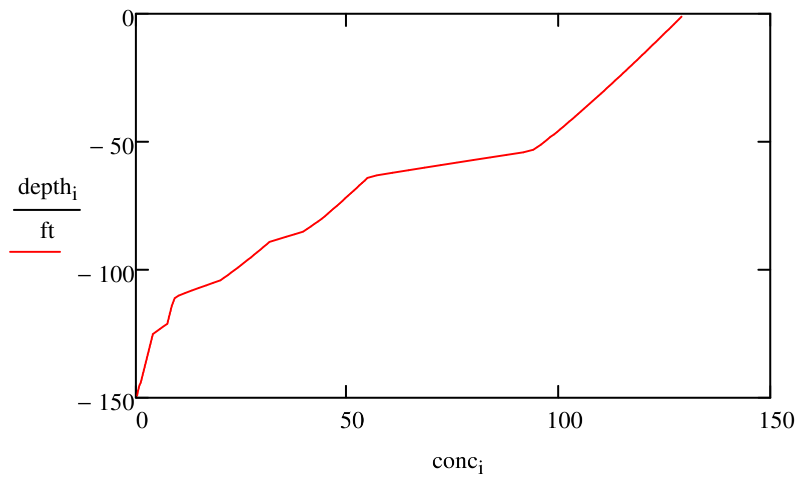

Figure 1. Soil Screening Levels (in ppm) at Various Depths from Ground Surface

sec-butylbenzene.xls

conc

Worksheet D-9
Site-specific Soil Screening Levels for the Protection of Groundwater - 1,2-Dichloroethane

Project Number 010627.003.0

Calculated by: Miao Zhang
Date: May 30, 2008

The following calculation is based on Appendix A (referred to as Appendix A in this calculation), "Attenuation Factor Method For VOCs" of "Interim Site Assessment & Cleanup Guidebook" published by the California Regional Water Quality Control Board, Los Angeles Region (referred to as the LARWQCB method in this calculation).

1. Maximum Attenuation Factor (AFmax)

$AFmax := 17$ (Table 2 of Appendix A)

2. Modification Factor Due to Distance Above Groundwater (AFD)

- depth to groundwater = $DT := 150ft$

$i := 1 .. 149$

depth to water from point of Interst = $D_i := DT - i \cdot ft$

$$AFD_i := \begin{cases} \max(1, AFmax) & \text{if } D_i > 150ft \\ \max\left[1, \left(0.9\dfrac{D_i - 40ft}{110ft} + 0.1\right) \cdot AFmax\right] & \text{if } 40ft < D_i \le 150ft \\ \max\left[1, \dfrac{D_i}{40ft} \cdot (0.1AFmax - 1) + 1\right] & \text{if } D_i \le 40ft \end{cases}$$

(Equations 5-7 of Appendix A)

3. Total Modification Factor Due to Distance Above Groundwater and Lithology (AFT)

- boring information::

$i := 1 .. 150$

$GR125_i := 0 \quad SA125_i := 0 \quad SI125_i := 0 \quad CL125_i := 0$

$GR126_i := 0 \quad SA126_i := 0 \quad SI126_i := 0 \quad CL126_i := 0$

Boring No. 125

1' - 15': Silty Sand	$i := 1..15$	$SA125_i := 1$
15' - 19': Poorly Graded Sand	$i := 16..19$	$SA125_i := 1$
19' - 25': Silty Sand	$i := 20..25$	$SA125_i := 1$
25' - 47': Poorly Graded Sand	$i := 26..47$	$SA125_i := 1$
47' - 48': Sandy Silt	$i := 48..48$	$SI125_i := 1$
48' - 54': Silty Sand	$i := 49..54$	$SA125_i := 1$
54' - 64': Lean Clay	$i := 55..64$	$CL125_i := 1$
64' - 80': Poorly Graded Sand	$i := 65..80$	$SA125_i := 1$
80' - 85': Sandy Silt	$i := 81..85$	$SI125_i := 1$
85' - 89': Sandy Lean Clay	$i := 86..89$	$CL125_i := 1$
89' - 106': Poorly Graded Sand	$i := 90..106$	$SA125_i := 1$
106' - 114': Sandy Silt	$i := 107..114$	$SI125_i := 1$
114 - 121': Poorly Graded Sand	$i := 115..121$	$SA125_i := 1$
121 - 125': Silty Sand	$i := 122..125$	$SA125_i := 1$
125' - 144': Poorly Graded Sand	$i := 126..144$	$SA125_i := 1$
144' - 145': Silt	$i := 145..145$	$SI125_i := 1$
145' - 150': Poorly Graded Sand	$i := 146..150$	$SA125_i := 1$

Boring No. 126

1' - 8': Silty Sand	$i := 1..8$	$SA126_i := 1$
8' - 46': Poorly Graded Sand	$i := 9..46$	$SA126_i := 1$
46' - 51': Silty Sand	$i := 47..51$	$SA126_i := 1$
51' - 53': Silt	$i := 52..53$	$SI126_i := 1$
53' - 63': Lean Clay	$i := 54..63$	$CL126_i := 1$
63' - 69': Silty Sand	$i := 64..69$	$SA126_i := 1$
69' - 104': Poorly Graded Sand	$i := 70..104$	$SA126_i := 1$
104' - 111': Lean Clay	$i := 105..111$	$CL126_i := 1$
111' - 121': Poorly Graded Sand	$i := 112..121$	$SA126_i := 1$
121' - 125: Lean Clay	$i := 122..125$	$CL126_i := 1$
125 - 135: Poorly Graded Sand	$i := 126..135$	$SA126_i := 1$
135 - 140': Silty Sand	$i := 136..140$	$SA126_i := 1$
140' - 150': Poorly Graded Sand	$i := 141..150$	$SA126_i := 1$

$$i := 1 .. 149$$

$$TGR_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} GR125_j + \sum_{j=i+1}^{\frac{DT}{ft}} GR126_j\right)$$

$$TSA_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} SA125_j + \sum_{j=i+1}^{\frac{DT}{ft}} SA126_j\right)$$

$$TSI_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} SI125_j + \sum_{j=i+1}^{\frac{DT}{ft}} SI126_j\right)$$

$$TCL_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} CL125_j + \sum_{j=i+1}^{\frac{DT}{ft}} CL126_j\right)$$

$$AFT_i := \max\left[1, \frac{AFD_i}{\frac{D_i}{ft}} \cdot \left(\frac{TGR_i}{20} + \frac{TSA_i}{10} + \frac{TSI_i}{5} + \frac{TCL_i}{1}\right)\right]$$ (Equation 12 of Appendix A)

4. Use of Attenuation Factor for VOC Soil Screening Levels

- water quality objective (WQO) $WQO := 0.0005$ (California DHS Notification Level, in ppm)

$$i := 1 .. 149$$

$$conc_i := AFT_i \cdot WQO$$ (Equation 13 of Appendix A)

depth of point of interest: $depth_i := -i \cdot ft$

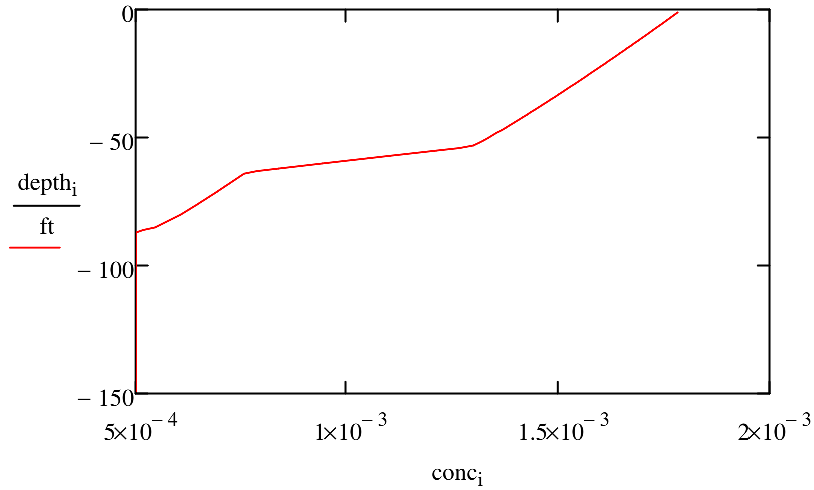

Figure 1. Soil Screening Levels (in ppm) at Various Depths from Ground Surface

12-dca.xls

conc

Worksheet D-10
Site-specific Soil Screening Levels for the Protection of Groundwater - Isopropylbenzene

Project Number 010627.003.0

Calculated by: Miao Zhang
Date: June 26, 2007
Revision: December 17, 2007

The following calculation is based on Appendix A (referred to as Appendix A in this calculation), "Attenuation Factor Method For VOCs" of "Interim Site Assessment & Cleanup Guidebook" published by the California Regional Water Quality Control Board, Los Angeles Region (referred to as the LARWQCB method in this calculation).

1. Maximum Attenuation Factor (AFmax)

- maximum attenuation factor

Non-chemical-specific Parameters

soil bulk density	$\mathrm{denb} := 2.27 \frac{\mathrm{g}}{\mathrm{mL}}$
soil water content by volume (dimensionless)	$\mathrm{thetaw} := 0.031$
soil organic carbon content (dimensionless)	$\mathrm{foc} := 0.015$
soil porosity (dimensionless)	$\mathrm{n} := 0.143$

Chemical-specific Parameters

organic carbon partition coefficient	$\mathrm{Koc} := 220 \frac{\mathrm{mL}}{\mathrm{g}}$
Henry's law constant	$\mathrm{Kh} := 0.472$

Reference: U.S. EPA, 2004, Region IX Preliminary Remediation Goals (PRGs)
http://www.epa.gov/region09/waste/sfund/prg/index.html

Maximum Attenution Factor

$$\mathrm{AFmax} := 1 + \left(\frac{\mathrm{denb}}{\mathrm{thetaw}}\right) \cdot \mathrm{foc} \cdot \mathrm{Koc} + (\mathrm{n} - \mathrm{thetaw}) \cdot \frac{\mathrm{Kh}}{\mathrm{thetaw}}$$ (Equation 4 of Appendix A)

$$\mathrm{AFmax} = 244.35$$

2. Modification Factor Due to Distance Above Groundwater (AFD)

- depth to groundwater = $\mathrm{DT} := 150\mathrm{ft}$

$i := 1 .. 149$

depth to water from point of Interst = $D_i := DT - i \cdot ft$

$$AFD_i := \begin{cases} \max(1, AFmax) & \text{if } D_i > 150ft \\ \max\left[1, \left(0.9 \dfrac{D_i - 40ft}{110ft} + 0.1\right) \cdot AFmax\right] & \text{if } 40ft < D_i \le 150ft \\ \max\left[1, \dfrac{D_i}{40ft} \cdot (0.1AFmax - 1) + 1\right] & \text{if } D_i \le 40ft \end{cases}$$

(Equations 5-7 of Appendix A)

3. Total Modification Factor Due to Distance Above Groundwater and Lithology (AFT)

- boring information::

$i := 1..150$

$GR125_i := 0 \quad SA125_i := 0 \quad SI125_i := 0 \quad CL125_i := 0$

$GR126_i := 0 \quad SA126_i := 0 \quad SI126_i := 0 \quad CL126_i := 0$

Boring No. 125

1' - 15': Silty Sand	$i := 1..15$	$SA125_i := 1$
15' - 19': Poorly Graded Sand	$i := 16..19$	$SA125_i := 1$
19' - 25': Silty Sand	$i := 20..25$	$SA125_i := 1$
25' - 47': Poorly Graded Sand	$i := 26..47$	$SA125_i := 1$
47' - 48': Sandy Silt	$i := 48..48$	$SI125_i := 1$
48' - 54': Silty Sand	$i := 49..54$	$SA125_i := 1$
54' - 64': Lean Clay	$i := 55..64$	$CL125_i := 1$
64' - 80': Poorly Graded Sand	$i := 65..80$	$SA125_i := 1$
80' - 85': Sandy Silt	$i := 81..85$	$SI125_i := 1$
85' - 89': Sandy Lean Clay	$i := 86..89$	$CL125_i := 1$
89' - 106': Poorly Graded Sand	$i := 90..106$	$SA125_i := 1$
106' - 114': Sandy Silt	$i := 107..114$	$SI125_i := 1$
114 - 121': Poorly Graded Sand	$i := 115..121$	$SA125_i := 1$
121 - 125': Silty Sand	$i := 122..125$	$SA125_i := 1$
125' - 144': Poorly Graded Sand	$i := 126..144$	$SA125_i := 1$
144' - 145': Silt	$i := 145..145$	$SI125_i := 1$
145' - 150': Poorly Graded Sand	$i := 146..150$	$SA125_i := 1$

Boring No. 126

1' - 8': Silty Sand	$i := 1..8$	$SA126_i := 1$
8' - 46': Poorly Graded Sand	$i := 9..46$	$SA126_i := 1$
46' - 51': Silty Sand	$i := 47..51$	$SA126_i := 1$
51' - 53': Silt	$i := 52..53$	$SI126_i := 1$
53' - 63': Lean Clay	$i := 54..63$	$CL126_i := 1$
63' - 69': Silty Sand	$i := 64..69$	$SA126_i := 1$
69' - 104': Poorly Graded Sand	$i := 70..104$	$SA126_i := 1$
104' - 111': Lean Clay	$i := 105..111$	$CL126_i := 1$
111' - 121': Poorly Graded Sand	$i := 112..121$	$SA126_i := 1$
121' - 125: Lean Clay	$i := 122..125$	$CL126_i := 1$
125 - 135: Poorly Graded Sand	$i := 126..135$	$SA126_i := 1$
135 - 140': Silty Sand	$i := 136..140$	$SA126_i := 1$
140' - 150': Poorly Graded Sand	$i := 141..150$	$SA126_i := 1$

$i := 1..149$

$$TGR_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} GR125_j + \sum_{j=i+1}^{\frac{DT}{ft}} GR126_j\right)$$

$$TSA_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} SA125_j + \sum_{j=i+1}^{\frac{DT}{ft}} SA126_j\right)$$

$$TSI_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} SI125_j + \sum_{j=i+1}^{\frac{DT}{ft}} SI126_j\right)$$

$$TCL_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} CL125_j + \sum_{j=i+1}^{\frac{DT}{ft}} CL126_j\right)$$

$$AFT_i := \max\left[1, \frac{AFD_i}{\frac{D_i}{ft}} \cdot \left(\frac{TGR_i}{20} + \frac{TSA_i}{10} + \frac{TSI_i}{5} + \frac{TCL_i}{1}\right)\right]$$ (Equation 12 of Appendix A)

4. Use of Attenuation Factor for VOC Soil Screening Levels

- water quality objective (WQO) $WQO := 0.77$ (California DHS Notification Level, in ppm)

$i := 1..149$

$conc_i := AFT_i \cdot WQO$ (Equation 13 of Appendix A)

depth of point of interest: $depth_i := -i \cdot ft$

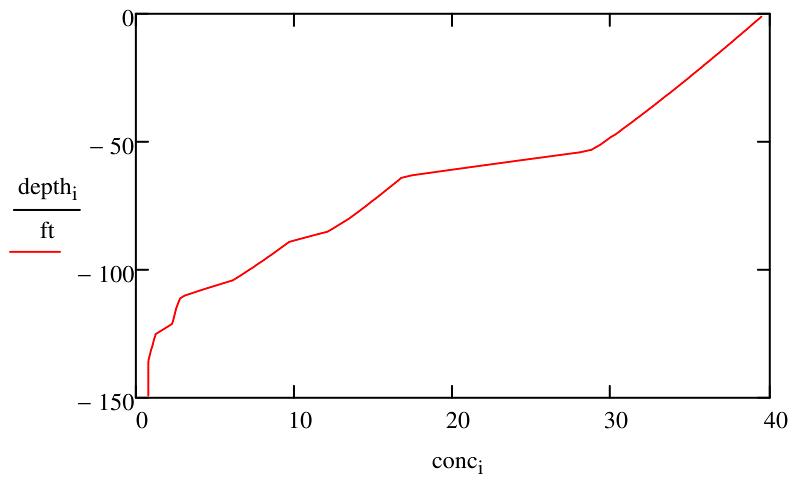

Figure 1. Soil Screening Levels (in ppm) at Various Depths from Ground Surface

isopropylbenzene.xls

conc

<u>Worksheet D-11</u>
<u>Site-specific Soil Screening Levels for the Protection of Groundwater - Isopropyltoluene</u>

Project Number 010627.003.0

Calculated by: Miao Zhang
Date: June 26, 2007
Revision: December 17, 2007

The following calculation is based on Appendix A (referred to as Appendix A in this calculation), "Attenuation Factor Method For VOCs" of "Interim Site Assessment & Cleanup Guidebook" published by the California Regional Water Quality Control Board, Los Angeles Region (referred to as the LARWQCB method in this calculation).

1. Maximum Attenuation Factor (AFmax)

- maximum attenuation factor

Non-chemical-specific Parameters

soil bulk density $\mathrm{denb} := 2.27\,\frac{g}{mL}$

soil water content by volume (dimensionless) $\mathrm{thetaw} := 0.031$

soil organic carbon content (dimensionless) $\mathrm{foc} := 0.015$

soil porosity (dimensionless) $n := 0.143$

Chemical-specific Parameters

organic carbon partition coefficient $\mathrm{Koc} := 3350\,\frac{mL}{g}$

Reference: PA Phys Prop Database, PA State Dept Bureau of Land Recycling
http://www.dep.state.pa.us/physicalproperties/_cgi-bin/Koc.idc

Henry's law constant $\mathrm{Kh} := 0.508$

Reference: SRC, PhysProp Database, Syracuse Research Corporation,
http://www.syrres.com/esc/physdemo.htm

Maximum Attenution Factor

$$\mathrm{AFmax} := 1 + \left(\frac{\mathrm{denb}}{\mathrm{thetaw}}\right)\cdot \mathrm{foc}\cdot \mathrm{Koc} + (n - \mathrm{thetaw})\cdot \frac{\mathrm{Kh}}{\mathrm{thetaw}}$$ (Equation 4 of Appendix A)

$$\mathrm{AFmax} = 3.682\times 10^{3}$$

2. Modification Factor Due to Distance Above Groundwater (AFD)

- depth to groundwater = $\mathrm{DT} := 150\mathrm{ft}$

$i := 1..149$

depth to water from point of Interst = $D_i := DT - i \cdot ft$

$$AFD_i := \begin{cases} \max(1, AFmax) & \text{if } D_i > 150ft \\ \max\left[1, \left(0.9\dfrac{D_i - 40ft}{110ft} + 0.1\right) \cdot AFmax\right] & \text{if } 40ft < D_i \le 150ft \\ \max\left[1, \dfrac{D_i}{40ft} \cdot (0.1AFmax - 1) + 1\right] & \text{if } D_i \le 40ft \end{cases}$$

(Equations 5-7 of Appendix A)

3. Total Modification Factor Due to Distance Above Groundwater and Lithology (AFT)

- boring information::

$i := 1..150$

$GR125_i := 0 \quad SA125_i := 0 \quad SI125_i := 0 \quad CL125_i := 0$

$GR126_i := 0 \quad SA126_i := 0 \quad SI126_i := 0 \quad CL126_i := 0$

Boring No. 125

1' - 15': Silty Sand	$i := 1..15$	$SA125_i := 1$
15' - 19': Poorly Graded Sand	$i := 16..19$	$SA125_i := 1$
19' - 25': Silty Sand	$i := 20..25$	$SA125_i := 1$
25' - 47': Poorly Graded Sand	$i := 26..47$	$SA125_i := 1$
47' - 48': Sandy Silt	$i := 48..48$	$SI125_i := 1$
48' - 54': Silty Sand	$i := 49..54$	$SA125_i := 1$
54' - 64': Lean Clay	$i := 55..64$	$CL125_i := 1$
64' - 80': Poorly Graded Sand	$i := 65..80$	$SA125_i := 1$
80' - 85': Sandy Silt	$i := 81..85$	$SI125_i := 1$
85' - 89': Sandy Lean Clay	$i := 86..89$	$CL125_i := 1$
89' - 106': Poorly Graded Sand	$i := 90..106$	$SA125_i := 1$
106' - 114': Sandy Silt	$i := 107..114$	$SI125_i := 1$
114 - 121': Poorly Graded Sand	$i := 115..121$	$SA125_i := 1$
121 - 125': Silty Sand	$i := 122..125$	$SA125_i := 1$
125' - 144': Poorly Graded Sand	$i := 126..144$	$SA125_i := 1$
144' - 145': Silt	$i := 145..145$	$SI125_i := 1$
145' - 150': Poorly Graded Sand	$i := 146..150$	$SA125_i := 1$

Boring No. 126

1' - 8': Silty Sand	$i := 1..8$	$SA126_i := 1$
8' - 46': Poorly Graded Sand	$i := 9..46$	$SA126_i := 1$
46' - 51': Silty Sand	$i := 47..51$	$SA126_i := 1$
51' - 53': Silt	$i := 52..53$	$SI126_i := 1$
53' - 63': Lean Clay	$i := 54..63$	$CL126_i := 1$
63' - 69': Silty Sand	$i := 64..69$	$SA126_i := 1$
69' - 104': Poorly Graded Sand	$i := 70..104$	$SA126_i := 1$
104' - 111': Lean Clay	$i := 105..111$	$CL126_i := 1$
111' - 121': Poorly Graded Sand	$i := 112..121$	$SA126_i := 1$
121' - 125: Lean Clay	$i := 122..125$	$CL126_i := 1$
125 - 135: Poorly Graded Sand	$i := 126..135$	$SA126_i := 1$
135 - 140': Silty Sand	$i := 136..140$	$SA126_i := 1$
140' - 150': Poorly Graded Sand	$i := 141..150$	$SA126_i := 1$

$i := 1..149$

$$TGR_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} GR125_j + \sum_{j=i+1}^{\frac{DT}{ft}} GR126_j\right)$$

$$TSA_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} SA125_j + \sum_{j=i+1}^{\frac{DT}{ft}} SA126_j\right)$$

$$TSI_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} SI125_j + \sum_{j=i+1}^{\frac{DT}{ft}} SI126_j\right)$$

$$TCL_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} CL125_j + \sum_{j=i+1}^{\frac{DT}{ft}} CL126_j\right)$$

$$AFT_i := \max\left[1, \frac{AFD_i}{\frac{D_i}{ft}} \cdot \left(\frac{TGR_i}{20} + \frac{TSA_i}{10} + \frac{TSI_i}{5} + \frac{TCL_i}{1}\right)\right]$$ (Equation 12 of Appendix A)

4. Use of Attenuation Factor for VOC Soil Screening Levels

- water quality objective (WQO) $WQO := 0.77$ (California DHS Notification Level for isopropyltoluene as surrogate, in ppm)

$i := 1 .. 149$

$conc_i := AFT_i \cdot WQO$ (Equation 13 of Appendix A)

depth of point of interest: $depth_i := -i \cdot ft$

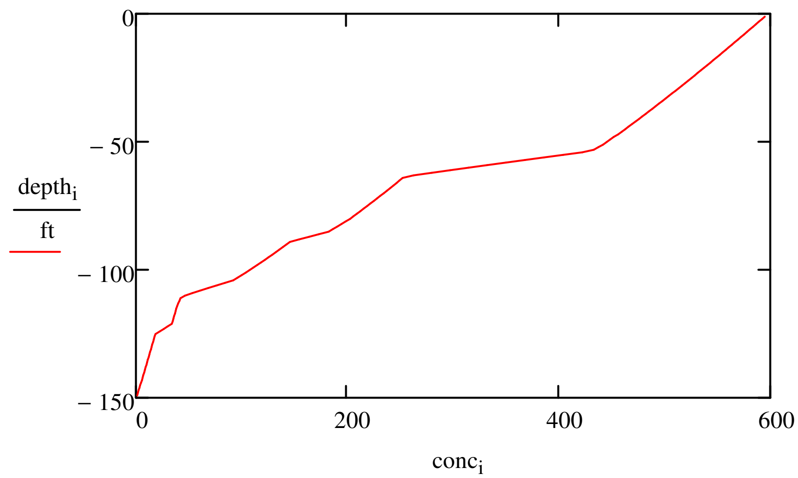

Figure 1. Soil Screening Levels (in ppm) at Various Depths from Ground Surface

isopropyltoluene.xls

conc

Worksheet D-12
Site-specific Soil Screening Levels for the Protection of Groundwater - n-Propylbenzene

Project Number 010627.003.0

Calculated by: Miao Zhang
Date: June 26, 2007
Revision: December 17, 2007

The following calculation is based on Appendix A (referred to as Appendix A in this calculation), "Attenuation Factor Method For VOCs" of "Interim Site Assessment & Cleanup Guidebook" published by the California Regional Water Quality Control Board, Los Angeles Region (referred to as the LARWQCB method in this calculation).

1. Maximum Attenuation Factor (AFmax)

- maximum attenuation factor

Non-chemical-specific Parameters

soil bulk density	$\mathrm{denb} := 2.27 \frac{\mathrm{g}}{\mathrm{mL}}$
soil water content by volume (dimensionless)	$\mathrm{thetaw} := 0.031$
soil organic carbon content (dimensionless)	$\mathrm{foc} := 0.015$
soil porosity (dimensionless)	$\mathrm{n} := 0.143$

Chemical-specific Parameters

organic carbon partition coefficient	$\mathrm{Koc} := 2830 \frac{\mathrm{mL}}{\mathrm{g}}$
Henry's law constant	$\mathrm{Kh} := 0.537$

Reference: U.S. EPA, 2004, Region IX Preliminary Remediation Goals (PRGs)
http://www.epa.gov/region09/waste/sfund/prg/index.html

Maximum Attenution Factor

$$\mathrm{AFmax} := 1 + \left(\frac{\mathrm{denb}}{\mathrm{thetaw}}\right)\cdot\mathrm{foc}\cdot\mathrm{Koc} + (\mathrm{n} - \mathrm{thetaw})\cdot\frac{\mathrm{Kh}}{\mathrm{thetaw}}$$ (Equation 4 of Appendix A)

$$\mathrm{AFmax} = 3.111 \times 10^{3}$$

2. Modification Factor Due to Distance Above Groundwater (AFD)

- depth to groundwater = $\mathrm{DT} := 150\mathrm{ft}$

$i := 1..149$

depth to water from point of Interst = $D_i := DT - i \cdot ft$

$$AFD_i := \begin{cases} \max(1, AFmax) & \text{if } D_i > 150ft \\ \max\left[1, \left(0.9\dfrac{D_i - 40ft}{110ft} + 0.1\right) \cdot AFmax\right] & \text{if } 40ft < D_i \le 150ft \\ \max\left[1, \dfrac{D_i}{40ft} \cdot (0.1AFmax - 1) + 1\right] & \text{if } D_i \le 40ft \end{cases}$$

(Equations 5-7 of Appendix A)

3. Total Modification Factor Due to Distance Above Groundwater and Lithology (AFT)

- boring information::

$i := 1..150$

$GR125_i := 0$ $SA125_i := 0$ $SI125_i := 0$ $CL125_i := 0$

$GR126_i := 0$ $SA126_i := 0$ $SI126_i := 0$ $CL126_i := 0$

Boring No. 125

1' - 15': Silty Sand	$i := 1..15$	$SA125_i := 1$
15' - 19': Poorly Graded Sand	$i := 16..19$	$SA125_i := 1$
19' - 25': Silty Sand	$i := 20..25$	$SA125_i := 1$
25' - 47': Poorly Graded Sand	$i := 26..47$	$SA125_i := 1$
47' - 48': Sandy Silt	$i := 48..48$	$SI125_i := 1$
48' - 54': Silty Sand	$i := 49..54$	$SA125_i := 1$
54' - 64': Lean Clay	$i := 55..64$	$CL125_i := 1$
64' - 80': Poorly Graded Sand	$i := 65..80$	$SA125_i := 1$
80' - 85': Sandy Silt	$i := 81..85$	$SI125_i := 1$
85' - 89': Sandy Lean Clay	$i := 86..89$	$CL125_i := 1$
89' - 106': Poorly Graded Sand	$i := 90..106$	$SA125_i := 1$
106' - 114': Sandy Silt	$i := 107..114$	$SI125_i := 1$
114 - 121': Poorly Graded Sand	$i := 115..121$	$SA125_i := 1$
121 - 125': Silty Sand	$i := 122..125$	$SA125_i := 1$
125' - 144': Poorly Graded Sand	$i := 126..144$	$SA125_i := 1$
144' - 145': Silt	$i := 145..145$	$SI125_i := 1$
145' - 150': Poorly Graded Sand	$i := 146..150$	$SA125_i := 1$

Boring No. 126

1' - 8': Silty Sand	$i := 1..8$	$SA126_i := 1$
8' - 46': Poorly Graded Sand	$i := 9..46$	$SA126_i := 1$
46' - 51': Silty Sand	$i := 47..51$	$SA126_i := 1$
51' - 53': Silt	$i := 52..53$	$SI126_i := 1$
53' - 63': Lean Clay	$i := 54..63$	$CL126_i := 1$
63' - 69': Silty Sand	$i := 64..69$	$SA126_i := 1$
69' - 104': Poorly Graded Sand	$i := 70..104$	$SA126_i := 1$
104' - 111': Lean Clay	$i := 105..111$	$CL126_i := 1$
111' - 121': Poorly Graded Sand	$i := 112..121$	$SA126_i := 1$
121' - 125: Lean Clay	$i := 122..125$	$CL126_i := 1$
125 - 135: Poorly Graded Sand	$i := 126..135$	$SA126_i := 1$
135 - 140': Silty Sand	$i := 136..140$	$SA126_i := 1$
140' - 150': Poorly Graded Sand	$i := 141..150$	$SA126_i := 1$

$i := 1..149$

$$TGR_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} GR125_j + \sum_{j=i+1}^{\frac{DT}{ft}} GR126_j\right)$$

$$TSA_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} SA125_j + \sum_{j=i+1}^{\frac{DT}{ft}} SA126_j\right)$$

$$TSI_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} SI125_j + \sum_{j=i+1}^{\frac{DT}{ft}} SI126_j\right)$$

$$TCL_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} CL125_j + \sum_{j=i+1}^{\frac{DT}{ft}} CL126_j\right)$$

$$AFT_i := \max\left[1, \frac{AFD_i}{\frac{D_i}{ft}} \cdot \left(\frac{TGR_i}{20} + \frac{TSA_i}{10} + \frac{TSI_i}{5} + \frac{TCL_i}{1}\right)\right]$$ (Equation 12 of Appendix A)

4. Use of Attenuation Factor for VOC Soil Screening Levels

- water quality objective (WQO) $WQO := 0.26$ (California DHS Notification Level, in ppm)

$i := 1 .. 149$

$conc_i := AFT_i \cdot WQO$ (Equation 13 of Appendix A)

depth of point of interest: $depth_i := -i \cdot ft$

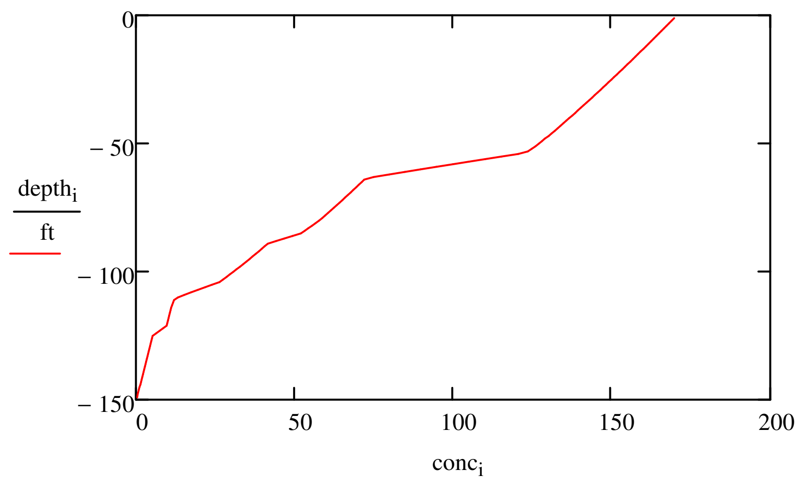

Figure 1. Soil Screening Levels (in ppm) at Various Depths from Ground Surface

n-propylbenzene.xls

conc

Worksheet D-13
Site-specific Soil Screening Levels for the Protection of Groundwater - 1,2,4-Trimethylbenzene

Project Number 010627.003.0

Calculated by: Miao Zhang
Date: June 26, 2007
Revision: December 17, 2007

The following calculation is based on Appendix A (referred to as Appendix A in this calculation), "Attenuation Factor Method For VOCs" of "Interim Site Assessment & Cleanup Guidebook" published by the California Regional Water Quality Control Board, Los Angeles Region (referred to as the LARWQCB method in this calculation).

1. Maximum Attenuation Factor (AFmax)

- maximum attenuation factor

Non-chemical-specific Parameters

soil bulk density $\mathrm{denb} := 2.27\,\frac{\mathrm{g}}{\mathrm{mL}}$

soil water content by volume (dimensionless) $\mathrm{thetaw} := 0.031$

soil organic carbon content (dimensionless) $\mathrm{foc} := 0.015$

soil porosity (dimensionless) $\mathrm{n} := 0.143$

Chemical-specific Parameters

organic carbon partition coefficient $\mathrm{Koc} := 3720\,\frac{\mathrm{mL}}{\mathrm{g}}$

Henry's law constant $\mathrm{Kh} := 0.234$

Reference: U.S. EPA, 2004, Region IX Preliminary Remediation Goals (PRGs)
http://www.epa.gov/region09/waste/sfund/prg/index.html

Maximum Attenution Factor

$$\mathrm{AFmax} := 1 + \left(\frac{\mathrm{denb}}{\mathrm{thetaw}}\right)\cdot \mathrm{foc}\cdot \mathrm{Koc} + (\mathrm{n} - \mathrm{thetaw})\cdot \frac{\mathrm{Kh}}{\mathrm{thetaw}}$$ (Equation 4 of Appendix A)

$$\mathrm{AFmax} = 4.088 \times 10^{3}$$

2. Modification Factor Due to Distance Above Groundwater (AFD)

- depth to groundwater = $\mathrm{DT} := 150\mathrm{ft}$

$\mathrm{i} := 1 .. 149$

depth to water from point of Interst = $D_i := DT - i \cdot ft$

$$AFD_i := \begin{cases} \max(1, AFmax) & \text{if } D_i > 150ft \\ \max\left[1, \left(0.9\frac{D_i - 40ft}{110ft} + 0.1\right) \cdot AFmax\right] & \text{if } 40ft < D_i \le 150ft \\ \max\left[1, \frac{D_i}{40ft} \cdot (0.1AFmax - 1) + 1\right] & \text{if } D_i \le 40ft \end{cases}$$

(Equations 5-7 of Appendix A)

3. Total Modification Factor Due to Distance Above Groundwater and Lithology (AFT)

- boring information::

$i := 1..150$

$GR125_i := 0 \quad SA125_i := 0 \quad SI125_i := 0 \quad CL125_i := 0$

$GR126_i := 0 \quad SA126_i := 0 \quad SI126_i := 0 \quad CL126_i := 0$

Boring No. 125

1' - 15': Silty Sand	$i := 1..15$	$SA125_i := 1$
15' - 19': Poorly Graded Sand	$i := 16..19$	$SA125_i := 1$
19' - 25': Silty Sand	$i := 20..25$	$SA125_i := 1$
25' - 47': Poorly Graded Sand	$i := 26..47$	$SA125_i := 1$
47' - 48': Sandy Silt	$i := 48..48$	$SI125_i := 1$
48' - 54': Silty Sand	$i := 49..54$	$SA125_i := 1$
54' - 64': Lean Clay	$i := 55..64$	$CL125_i := 1$
64' - 80': Poorly Graded Sand	$i := 65..80$	$SA125_i := 1$
80' - 85': Sandy Silt	$i := 81..85$	$SI125_i := 1$
85' - 89': Sandy Lean Clay	$i := 86..89$	$CL125_i := 1$
89' - 106': Poorly Graded Sand	$i := 90..106$	$SA125_i := 1$
106' - 114': Sandy Silt	$i := 107..114$	$SI125_i := 1$
114 - 121': Poorly Graded Sand	$i := 115..121$	$SA125_i := 1$
121 - 125': Silty Sand	$i := 122..125$	$SA125_i := 1$
125' - 144': Poorly Graded Sand	$i := 126..144$	$SA125_i := 1$
144' - 145': Silt	$i := 145..145$	$SI125_i := 1$
145' - 150': Poorly Graded Sand	$i := 146..150$	$SA125_i := 1$

Boring No. 126

1' - 8': Silty Sand	$i := 1..8$	$SA126_i := 1$
8' - 46': Poorly Graded Sand	$i := 9..46$	$SA126_i := 1$
46' - 51': Silty Sand	$i := 47..51$	$SA126_i := 1$
51' - 53': Silt	$i := 52..53$	$SI126_i := 1$
53' - 63': Lean Clay	$i := 54..63$	$CL126_i := 1$
63' - 69': Silty Sand	$i := 64..69$	$SA126_i := 1$
69' - 104': Poorly Graded Sand	$i := 70..104$	$SA126_i := 1$
104' - 111': Lean Clay	$i := 105..111$	$CL126_i := 1$
111' - 121': Poorly Graded Sand	$i := 112..121$	$SA126_i := 1$
121' - 125: Lean Clay	$i := 122..125$	$CL126_i := 1$
125 - 135: Poorly Graded Sand	$i := 126..135$	$SA126_i := 1$
135 - 140': Silty Sand	$i := 136..140$	$SA126_i := 1$
140' - 150': Poorly Graded Sand	$i := 141..150$	$SA126_i := 1$

$i := 1..149$

$$TGR_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} GR125_j + \sum_{j=i+1}^{\frac{DT}{ft}} GR126_j\right)$$

$$TSA_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} SA125_j + \sum_{j=i+1}^{\frac{DT}{ft}} SA126_j\right)$$

$$TSI_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} SI125_j + \sum_{j=i+1}^{\frac{DT}{ft}} SI126_j\right)$$

$$TCL_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} CL125_j + \sum_{j=i+1}^{\frac{DT}{ft}} CL126_j\right)$$

$$AFT_i := \max\left[1, \frac{AFD_i}{\frac{D_i}{ft}} \cdot \left(\frac{TGR_i}{20} + \frac{TSA_i}{10} + \frac{TSI_i}{5} + \frac{TCL_i}{1}\right)\right]$$ (Equation 12 of Appendix A)

4. Use of Attenuation Factor for VOC Soil Screening Levels

- water quality objective (WQO) $WQO := 0.33$ (California DHS Notification Level, in ppm)

$i := 1 .. 149$

$conc_i := AFT_i \cdot WQO$ (Equation 13 of Appendix A)

depth of point of interest: $depth_i := -i \cdot ft$

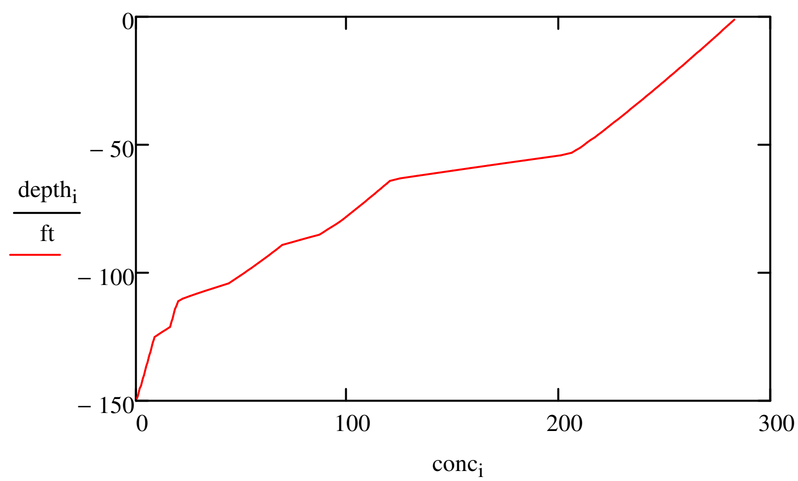

Figure 1. Soil Screening Levels (in ppm) at Various Depths from Ground Surface

depth.xls

124TMB.xls

$\frac{depth}{ft}$

conc

Worksheet D-14
Site-specific Soil Screening Levels for the Protection of Groundwater - 1,3,5-Trimethylbenzene

Project Number 010627.003.0

Calculated by: Miao Zhang
Date: June 26, 2007
Revision: December 17, 2007

The following calculation is based on Appendix A (referred to as Appendix A in this calculation), "Attenuation Factor Method For VOCs" of "Interim Site Assessment & Cleanup Guidebook" published by the California Regional Water Quality Control Board, Los Angeles Region (referred to as the LARWQCB method in this calculation).

1. Maximum Attenuation Factor (AFmax)

- maximum attenuation factor

Non-chemical-specific Parameters

soil bulk density $\mathrm{denb} := 2.27\,\frac{\mathrm{g}}{\mathrm{mL}}$

soil water content by volume (dimensionless) $\mathrm{thetaw} := 0.031$

soil organic carbon content (dimensionless) $\mathrm{foc} := 0.015$

soil porosity (dimensionless) $\mathrm{n} := 0.143$

Chemical-specific Parameters

organic carbon partition coefficient $\mathrm{Koc} := 819\,\frac{\mathrm{mL}}{\mathrm{g}}$

Henry's law constant $\mathrm{Kh} := 0.316$

Reference: U.S. EPA, 2004, Region IX Preliminary Remediation Goals (PRGs)
http://www.epa.gov/region09/waste/sfund/prg/index.html

Maximum Attenution Factor

$$\mathrm{AFmax} := 1 + \left(\frac{\mathrm{denb}}{\mathrm{thetaw}}\right)\cdot\mathrm{foc}\cdot\mathrm{Koc} + (\mathrm{n} - \mathrm{thetaw})\cdot\frac{\mathrm{Kh}}{\mathrm{thetaw}}$$ (Equation 4 of Appendix A)

$$\mathrm{AFmax} = 901.721$$

2. Modification Factor Due to Distance Above Groundwater (AFD)

- depth to groundwater = $\mathrm{DT} := 150\mathrm{ft}$

$\mathrm{i} := 1 .. 149$

depth to water from point of Interst = $D_i := DT - i \cdot ft$

$$AFD_i := \begin{cases} \max(1, AFmax) & \text{if } D_i > 150ft \\ \max\left[1, \left(0.9\dfrac{D_i - 40ft}{110ft} + 0.1\right) \cdot AFmax\right] & \text{if } 40ft < D_i \le 150ft \\ \max\left[1, \dfrac{D_i}{40ft} \cdot (0.1AFmax - 1) + 1\right] & \text{if } D_i \le 40ft \end{cases}$$

(Equations 5-7 of Appendix A)

3. Total Modification Factor Due to Distance Above Groundwater and Lithology (AFT)

- boring information::

$i := 1 .. 150$

$GR125_i := 0 \quad SA125_i := 0 \quad SI125_i := 0 \quad CL125_i := 0$

$GR126_i := 0 \quad SA126_i := 0 \quad SI126_i := 0 \quad CL126_i := 0$

Boring No. 125

1' - 15': Silty Sand	$i := 1 .. 15$	$SA125_i := 1$
15' - 19': Poorly Graded Sand	$i := 16 .. 19$	$SA125_i := 1$
19' - 25': Silty Sand	$i := 20 .. 25$	$SA125_i := 1$
25' - 47': Poorly Graded Sand	$i := 26 .. 47$	$SA125_i := 1$
47' - 48': Sandy Silt	$i := 48 .. 48$	$SI125_i := 1$
48' - 54': Silty Sand	$i := 49 .. 54$	$SA125_i := 1$
54' - 64': Lean Clay	$i := 55 .. 64$	$CL125_i := 1$
64' - 80': Poorly Graded Sand	$i := 65 .. 80$	$SA125_i := 1$
80' - 85': Sandy Silt	$i := 81 .. 85$	$SI125_i := 1$
85' - 89': Sandy Lean Clay	$i := 86 .. 89$	$CL125_i := 1$
89' - 106': Poorly Graded Sand	$i := 90 .. 106$	$SA125_i := 1$
106' - 114': Sandy Silt	$i := 107 .. 114$	$SI125_i := 1$
114 - 121': Poorly Graded Sand	$i := 115 .. 121$	$SA125_i := 1$
121 - 125': Silty Sand	$i := 122 .. 125$	$SA125_i := 1$
125' - 144': Poorly Graded Sand	$i := 126 .. 144$	$SA125_i := 1$
144' - 145': Silt	$i := 145 .. 145$	$SI125_i := 1$
145' - 150': Poorly Graded Sand	$i := 146 .. 150$	$SA125_i := 1$

Boring No. 126

1' - 8': Silty Sand	$i := 1..8$	$SA126_i := 1$
8' - 46': Poorly Graded Sand	$i := 9..46$	$SA126_i := 1$
46' - 51': Silty Sand	$i := 47..51$	$SA126_i := 1$
51' - 53': Silt	$i := 52..53$	$SI126_i := 1$
53' - 63': Lean Clay	$i := 54..63$	$CL126_i := 1$
63' - 69': Silty Sand	$i := 64..69$	$SA126_i := 1$
69' - 104': Poorly Graded Sand	$i := 70..104$	$SA126_i := 1$
104' - 111': Lean Clay	$i := 105..111$	$CL126_i := 1$
111' - 121': Poorly Graded Sand	$i := 112..121$	$SA126_i := 1$
121' - 125: Lean Clay	$i := 122..125$	$CL126_i := 1$
125 - 135: Poorly Graded Sand	$i := 126..135$	$SA126_i := 1$
135 - 140': Silty Sand	$i := 136..140$	$SA126_i := 1$
140' - 150': Poorly Graded Sand	$i := 141..150$	$SA126_i := 1$

$i := 1..149$

$$TGR_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} GR125_j + \sum_{j=i+1}^{\frac{DT}{ft}} GR126_j\right)$$

$$TSA_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} SA125_j + \sum_{j=i+1}^{\frac{DT}{ft}} SA126_j\right)$$

$$TSI_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} SI125_j + \sum_{j=i+1}^{\frac{DT}{ft}} SI126_j\right)$$

$$TCL_i := 0.5\left(\sum_{j=i+1}^{\frac{DT}{ft}} CL125_j + \sum_{j=i+1}^{\frac{DT}{ft}} CL126_j\right)$$

$$AFT_i := \max\left[1, \frac{AFD_i}{\frac{D_i}{ft}} \cdot \left(\frac{TGR_i}{20} + \frac{TSA_i}{10} + \frac{TSI_i}{5} + \frac{TCL_i}{1}\right)\right]$$ (Equation 12 of Appendix A)

4. Use of Attenuation Factor for VOC Soil Screening Levels

- water quality objective (WQO) $WQO := 0.33$ (California DHS Notification Level, in ppm)

$i := 1 .. 149$

$conc_i := AFT_i \cdot WQO$ (Equation 13 of Appendix A)

depth of point of interest: $depth_i := -i \cdot ft$

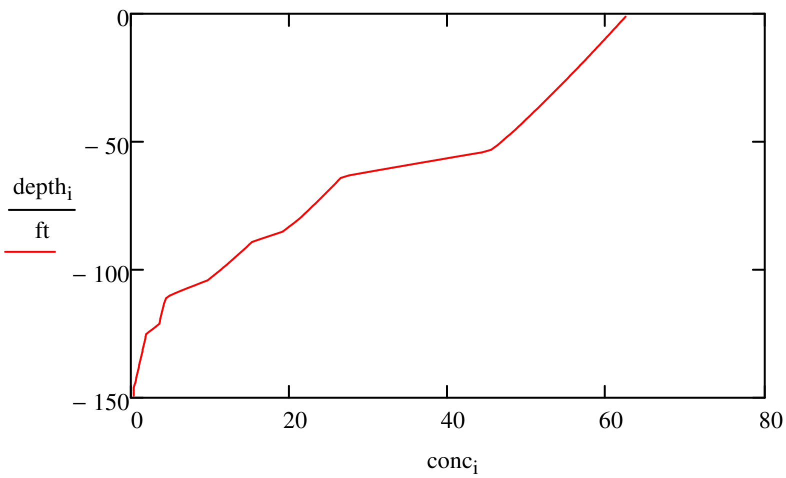

Figure 1. Soil Screening Levels (in ppm) at Various Depths from Ground Surface

135TMB.xls

conc

Worksheet D-15
Site-specific Modeling for the Protection of Groundwater – PCBs in Soil

Project Number 010627.003.0

Calculated by: Miao Zhang
Date: June 25, 2009

Define Unit: $\mu g := 10^{-6} gm$

Given Parameters:

PCB Solubility in Water $Sw := 0.7 \frac{mg}{L}$

Reference: U.S.EPA Soil Screening Guidance: User's Guide, 2nd Edition, July 1996

Maximum Contaminant Level for PCBs $MCL := 0.5 \cdot \frac{\mu g}{L}$

Calculations:

1. Source at 15 ft bgs

Assumed concentration in pore water at source in MODFLOW-SURFACT simulation:

$$Cps := 100 \frac{\mu g}{L}$$

MODFLOW-SURFACT simulated pore water concentration in layer 30 (just above groundwater table) after 500 years is below the smallest value that the mode can report ($1x10^{-44}$). Therefore, $1x10^{-44}$ is used as a conservative estimate of the simulated pore water concentration in layer 30.

$$Cws := 1 \cdot 10^{-44} \frac{\mu g}{L}$$

Attenuation factor (i.e. ratio of pore water concentration at source to pore water concentration in layer 30)

$$AF := \frac{Cps}{Cws} \qquad AF = 1 \times 10^{46}$$

Concentration in pore water at source that corresponds to a pore water concentration immediately above the water table equal to the MCL

$$Ci := MCL \cdot AF \qquad Ci = 5 \times 10^{42} \cdot \frac{mg}{L}$$

Ci >> Sw

2. Source at 30 ft bgs

Assumed concentration in pore water at source in MODFLOW-SURFACT simulation:

$$Cps := 100\,\frac{\mu g}{L}$$

MODFLOW-SURFACT simulated pore water concentration in layer 30 (just above groundwater table) after 500 years is below the smallest value that the mode can report ($1\text{x}10^{-44}$). Therefore, $1\text{x}10^{-44}$ is used as a conservative estimate of the simulated pore water concentration in layer 30.

$$Cws := 1\cdot 10^{-44}\,\frac{\mu g}{L}$$

Attenuation factor (i.e. ratio of pore water concentration at source to pore water concentration in layer 30)

$$AF := \frac{Cps}{Cws} \qquad AF = 1\times 10^{46}$$

Concentration in pore water at source that corresponds to a pore water concentration immediately above the water table equal to the MCL

$$Ci := MCL\cdot AF \qquad Ci = 5\times 10^{42}\cdot\frac{mg}{L}$$

Ci >> Sw

3. Source at 45 ft bgs

Assumed concentration in pore water at source in MODFLOW-SURFACT simulation:

$$Cps := 100\,\frac{\mu g}{L}$$

MODFLOW-SURFACT simulated pore water concentration in layer 30 (just above groundwater table) after 500 years

$$Cws := 4.64\cdot 10^{-43}\,\frac{\mu g}{L}$$

Attenuation factor (i.e. ratio of pore water concentration at source to pore water concentration in layer 30)

$$AF := \frac{Cps}{Cws} \qquad AF = 2.155\times 10^{44}$$

Concentration in pore water at source that corresponds to a pore water concentration immediately above the water table equal to the MCL

$$Ci := MCL\cdot AF \qquad Ci = 1.078\times 10^{41}\cdot\frac{mg}{L}$$

Ci >> Sw

Worksheet D-16
Site-specific Modeling for the Protection of Groundwater - PCBs in Crushed Concrete

Project Number 010627.003.0

Calculated by: Miao Zhang
Date: June 25, 2009

Define Unit: $\mu g := 10^{-6} gm$

Given Parameters:

PCB Solubility in Water $Sw := 0.7 \frac{mg}{L}$

Reference: U.S.EPA Soil Screening Guidance: User's Guide, 2nd Edition, July 1996

Maximum Contaminant Level for PCBs $MCL := 0.5 \cdot \frac{\mu g}{L}$

Calculations:

Source (crushed concrete) at 15 ft bgs

Assumed concentration in pore water at source in MODFLOW-SURFACT simulation:

$$Cps := 100 \frac{\mu g}{L}$$

MODFLOW-SURFACT simulated pore water concentration in layer 30 (just above groundwater table) after 500 years is below the smallest value that the mode can report ($1x10^{-44}$). Therefore, $1x10^{-44}$ is used as a conservative estimate of the simulated pore water concentration in layer 30.

$$Cws := 1 \cdot 10^{-44} \frac{\mu g}{L}$$

Attenuation factor (i.e. ratio of pore water concentration at source to pore water concentration in layer 30)

$$AF := \frac{Cps}{Cws} \qquad AF = 1 \times 10^{46}$$

Concentration in pore water at source that corresponds to a pore water concentration immediately above the water table equal to the MCL

$$Ci := MCL \cdot AF \qquad Ci = 5 \times 10^{42} \cdot \frac{mg}{L}$$

Ci >> Sw